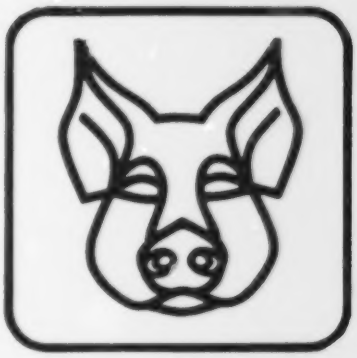
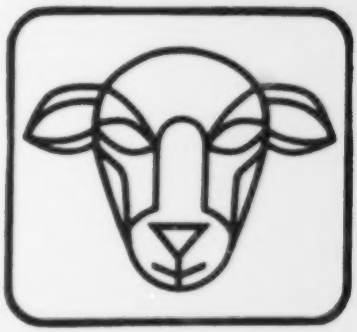
ISSN 0226 1197
Agdex 400





1986 MANITOBA ANIMAL INDUSTRY CONFERENCE PROCEEDINGS

A Forum for Professionals in Animal Agriculture

Manitoba Agriculture

MG-14643

87-03669/

A FIELD SURVEY

ON CALIBRATION OF ELECTRIC

PROPORTIONER HAMMER MILLS

Clarence Froese
Swine Program Specialist

Dennis Hodgkinson
Agricultural Engineer

Karen Dupchak
Assistant Animal Nutritionist

Manitoba Agriculture
Winnipeg, Manitoba

PRESENTED AT:

Animal Industry Conference
Ramada Inn
Winnipeg, Manitoba

December 9, 1986

Introduction

Many swine producers prepare their feed using on-farm milling and mixing equipment. One type of feed mill commonly used is the stationary electric proportioner hammer mill. These mills meter ingredients separately and blend them together in controlled flow rates. Blending occurs while the ingredients are being ground or during conveying of the ration. The addition rate for each ingredient is controlled by a metering device consisting of an auger whose revolution rate can be adjusted.

A critical procedure to ensure ingredient proportioning accuracy is routine calibration. Since the ingredients are metered by volume instead of weight, changes in ingredient characteristics can lead to addition rates significantly different from those intended. Periodic calibration checks are necessary to ensure that original mill settings are still producing the desired weight proportions of ingredients in the finished ration.

Reports received from extension staff and industry field staff indicate that mill calibration is often neglected because many producers fail to realize its importance in providing a nutritionally-adequate ration. An Ontario survey of 19 mills (Weeden and Norrish, 1981) concluded that a lack of mill calibration may be a major cause of unbalanced rations. The objective of this survey was to determine the extent to which routine mill calibration is understood and being practised amongst swine producers.

. . . /2

Methodology

Producers using electric proportioner mills in each agricultural extension region were identified by regional staff. From these, several survey sites were chosen in each region (Table 1). Mill calibration kits consisting of scales, containers of known volume and weight, and collection chutes were supplied to staff.

Prior to the calibration test, a data sheet outlining type and brand of ingredients used, formulation and proportioner dial settings for the ration being tested, and brand of mill was completed. Ingredients were then collected and weighed, and the actual proportions obtained were compared to those stated in the ration formulation. Samples of all ingredients used in the ration, and a finished feed sample were collected. Bulk density of each ingredient was also determined. If, for any ingredient, the actual inclusion rate as calculated by collection differed from the desired inclusion rate by more than five percent, the mill was recalibrated. After recalibration, another collection was done to determine if the desired proportions were now being obtained, and another finished feed sample was collected. The ingredient and finished feed samples were sent to the Provincial Feed Analysis Laboratory for nutrient analysis. If the ration formulation was not known, ingredient samples were still collected and actual ration ingredient proportions determined. Samples were sent for analysis but, due to the lack of a formulation, recalibration of the mill was not possible. Recommendations based on the ration formulations and ingredient analyses were sent to producers from the Feed Analysis Laboratory. These recommendations discussed the adequacy of the present ration and suggested changes in formulations and dial settings where necessary.

. . . /3

Results

A total of 43 mills from 42 producers were surveyed, consisting of 25 Mix Mill, 17 Farmatic, and 1 Beatty. One producer had two mills tested, accounting for the extra mill. Grower rations were the most commonly sampled, representing 30 of the 46 rations tested. Three producers sampled more than one ration from the same mill.

It was found that a low number of the producers surveyed were able to provide a formulation for their ration (Table 1). Only 17 out of 42 producers (40 percent) knew their ration formulations. For the remaining 25 producers, no assessment of proportioning accuracy could be made since the desired inclusion rates of the various ration ingredients were unknown.

Of the producers with a ration formulation, few were obtaining accurate ingredient proportions (Table 2). A mill was considered to be accurate if it was adding an ingredient at $\pm$ five percent of the desired rate. For example, if the desired inclusion rate for an ingredient was 100 kg/tonne, then the acceptable error range was 95-105 kg/tonne for that ingredient. Only 5 of the 18 mills (28 percent) were accurately adding all of the ingredients comprising the finished ration. Of the 13 mills out of calibration, 8 were adding every ration ingredient inaccurately.

The degree of addition rate error ranged widely (Table 3). Supplemental proteins were being added from 57 percent to 159 percent of the desired rate. The corresponding range for vitamin-mineral premixes was 72 percent to 136 percent.

. . . /4

During the survey, feed tags from commercial supplements or vitamin-mineral premixes used in each ration were collected. Table 4 compares the actual inclusion rates of these ingredients to those recommended by the manufacturers. On average, producers using commercial protein supplements were adding them at 87 percent of the recommended rate. Only 6 of these 16 producers were adding supplement at a rate that was within 10 percent of that recommended on the feed tag. Vitamin-mineral premixes were, on average, being added at 107 percent of the recommended rates (Table 5).

Only 5 out of 24 producers were adding premix at a rate within 10 percent of that recommended on the tag. Two producers were using a commercially-prepared custom blend of soybean meal and vitamin-mineral premix. Recommended addition rates were not available for these products.

Averages and ranges for the nutrient contents of 30 grower-finisher feed samples collected under the survey are given in Table 6. The averages generally meet or exceed minimum NRC requirements for the various nutrients listed. The wide ranges, however, indicate some serious deviations from these averages.

In Table 7, the 30 grower feeds are grouped according to their deviation from NRC minimums for various nutrients. Although only 5 of 30 rations were deficient in crude protein (Table 7), many of the rations were calculated to be deficient in lysine (Table 8). Ration lysine levels were calculated using a combination of standard NRC and feed industry ingredient values and the actual proportions of the various ingredients in the ration. Sixty percent of the rations were determined to be deficient in lysine (below 0.67 percent).

. . . /5

Of additional concern were calcium and phosphorous levels, and the resulting calcium:phosphorous ratios. Calcium and particularly phosphorous were well above NRC minimums in most cases. The result of these elevated levels was a narrowing of the calcium:phosphorous ratio, with the ratio in 20 out of 30 rations well below the recommended 1.2:1 level.

Discussion

The data collected by this survey, though a small sample, indicate a number of problem areas.

a) Formulation: Many producers do not recognize that having a known ration formulation is a critical part of any feed quality control program. All of the mills examined were obviously at one time set according to some formulation. However, in many cases the original formulation had either been forgotten or neglected. Rather than checking mill calibration against a known formulation, some producers instead were adjusting the dials according to the results of a finished feed sample. If, for example, the crude protein content was higher than required, the dial for the supplemental protein ingredient was set back slightly. This practise is dangerous for two reasons:

   i) the finished feed sample taken may not be a representative sample, giving an inaccurate picture. This is illustrated in Table 9, which shows the wide variation in feed test results obtained on one farm when the feed samples were taken at different sites in a storage pile.

. . . /6

ii) crude protein analysis is not a reliable indication of protein quality. Rations can contain high crude protein levels but still be deficient in some amino acids (particularly lysine) if the supplemental protein ingredient is being added at less than the recommended rate. For example, 10 of the 18 grower feed samples that were calculated to be deficient in lysine had crude protein values of 16 percent or higher. Producers who decrease the supplemental protein dial setting based on crude protein analysis may unknowingly reduce the lysine level in the ration below the minimum requirement.

To insure that the requirements for both protein quantity and quality are met, supplemental protein must be added at the rate specified in a proper ration formulation. Maintaining the accuracy of this addition rate by routine mill calibration checks in the most critical element of a quality control program. The same rationale applies to vitamin-mineral premixes. Dial settings for this ingredient should be based on monitored addition rates, rather than levels of calcium and phosphorous in samples of finished feed. Calibration accuracy is more important to good quality control than is feed analysis.

The question of whether proper formulations were readily available to producers was not specifically addressed in this study. Most feed tags list sample formulations and producers have access to professional advice through their feed representative or extension service.

. . . /7

A lack of information and assistance in developing a proper formulation should not be a probelm. It is alarming that so many producers do not use a ration formulation as a basis for setting, adjusting and monitoring their feed mills. This demonstrates a lack of appreciation of the importance of a proper formulation in producing a nutritionally balanced ration.

b) Calibration: The data from 17 producers where proportioning accuracy could be evaluated reveals a need for more emphasis on frequent calibration. The high proportion of mills out of calibration indicates a lack of routine calibration. Purkheiser et al (1984) suggest monthly calibration checks for each ration. (i.e., a producer making four rations would be doing a calibration every week). In addition, calibration should be checked when the bulk density of an ingredient changes by five percent or more, or when the moisture content changes by more than three percentage points. Many producers realize that changes in feed grain bushel weights affect proportioning accuracy. Most producers are unaware of the large variations in moisture content and density of the other commonly-used ingredients. Twenty-three soybean meal (44 percent) samples were collected by the survey. Bulk density ranged from 0.60-0.80 kg/L and moisture content from 6.4-12.1 percent. Similarly, 6 samples of commercial protein supplements all from one manufacturer ranged from 0.59-0.76 kg/L and 6.5-9.4 percent

. . . /8

moisture respectively. Eight samples of vitamin-mineral premixes from one manufacturer were 9.96-1.21 kg/L bulk density and 1.8-3.6 percent moisture. These figures illustrate the variable characteristics of all the ration ingredients, not just the feed grains. Some producers were reluctant to calibrate their mills because they had no convenient way to return the collected ingredients to storage bins. In such cases, the collected ingredients can be bagged and then returned to storage whenever bins are being refilled. A more serious problem sometimes encountered was the lack of accessibility to the back of the mill to allow set-up of calibration containers. Mills were sometimes set too close to a wall or surrounded by other obstructions. It is not surprising that operators neglect routine calibrations under such conditions. Access and convenience for calibration should be prime considerations when planning the feed room lay-out.

Calibration containers supplied with the mill were too small. Containers in which the feed grains were being collected filled very quickly while only a very small amount of premix was collected. In one case, weighing error of a small amount of premix sample caused the producer to over-estimate the premix addition rate by 33 percent.

The calibration method recommended by the manufacturer for mills equipped with electronic counters was slow to conduct and difficult

. . . /9

to understand. Routine calibration of these mills can be done using the same simultaneous method used for other mills. The simultaneous method requires much less time, making it more convenient and easier for producers to increase calibration frequency.

Testing Ration Ingredients

Routine testing of ration ingredients is commonly recommended. This survey raised some doubts about the usefulness of analyzed nutrient levels (crude protein, calcium, phosphorous) for on-farm formulation.

Improper and infrequent sampling will not provide an accurate assessment of nutrient content. Ration formulation based on analyses of these samples is thus risky. Samples must be taken properly and in sufficient number to ensure accuracy when determining nutrient levels.

Even an accurate estimation of crude protein content is of questionable value. It is difficult to use ingredient crude protein values in formulating rations because the relationship between crude protein and lysine in common feed grains is not well defined. Lysine content cannot be reliably estimated from the crude protein content at this time. Amino acid analyses are costly, difficult to obtain, and impractical as an on-farm quality control procedure. The most reliable and practical method of ensuring adequate nutrient levels for rations mixed on the farm is to base formulations on "standard" or normal values with an added safety margin.

. . . /10

Testing Finished Feeds

Laboratory analyses of finished feed samples collected in the survey often differed greatly from the expected analyses, even though the latter were based on analyzed nutrient levels of the individual ingredients. Such discrepancies arise because of improper sampling.

Both producers and advisory personnel often fail to interpret laboratory feed analyses results properly. Laboratory records show that less than half of the finished feed samples submitted include information on the ration formulation. This indicates that feed test results are used as the main criterion in judging ration adequacy, and the ration formulation is of minor concern in the evaluation. To determine their validity, analyzed values must be interpreted within the context of the ration formulation.

The present procedures practised by government and private advisory personnel in evaluating the adequacy of finished feeds place too much emphasis on feed testing. During the diagnoses of herd problems, for example, nutrition is often implicated or ruled out as a possible cause based solely on the results of a feed sample, with no consideration of proper formulation or mixing accuracy. This, in part, has led producers to the erroreous concept that testing of finished feeds is the most important aspect of effective feed quality control.

. . . /11

The role of feed testing in an on-farm quality control program must be de-emphasized. Of higher priority are:

a) proper ration design (formulation)

b) routine checking of mixing equipment to ensure that the formulation is actually achieved.

These factors will provide more consistent control of ration quality than feed testing and must receive more emphasis in the future.

. . . /12

References:

1. Purkheiser, E.D. and Bloome, P.D., Calibrating Meter-Type Feed Mills, Pork Industry Handbook, Purdue University, 1984.

2. Weeden, J.K. and Norrish, J.G., Stationary Blender-Grinders - A Field Evaluation, Proceedings of 61st AIC Conference, Brock University, 1981.

. . . /13

TABLE 1. SURVEY RESULTS OF ELECTRIC PROPORTIONER FEED MILLS IN MANITOBA

AG. REGION	NO. PRODUCERS SURVEYED	NO. PRODUCERS ABLE TO PROVIDE RATION FORMULATION
CENTRAL	4	1
EASTERN	9	6
INTERLAKE	12	6
NORTHWEST	10	2
SOUTHWEST	7	2
TOTAL	42	17

TABLE 2. CALIBRATION OF ELECTRIC PROPORTIONER FEED MILLS IN MANITOBA

* NUMBER MILLS IN CALIBRATION FOR ALL INGREDIENTS	5/18
NUMBER MILLS OUT OF CALIBRATION FOR ONE OR MORE INGREDIENT	13/18

* CALIBRATION ACCURACY DEFINED AS THE MEASURED PROPORTION BEING WITHIN FIVE PERCENT OF THAT DESIRED.

TABLE 3. RANGE OF ADDITION RATES BY TYPE OF INGREDIENT FOR MILLS OUT OF CALIBRATION

INGREDIENT TYPE	ADDITION RATE RANGE % OF DESIRED RATE
GRAIN	60 - 143
SUPPLEMENTAL PROTEIN	57 - 159
VITAMIN-MINERAL PREMIX	72 - 136

. . . /14

TABLE 4. ADDITION RATES OF COMMERCIAL PROTEIN SUPPLEMENTS COMPARED TO MANUFACTURERS' RECOMMENDATIONS

NO. PRODUCERS	ADDITION RATE (% OF RECOMMENDED RATE)	
	AVERAGE	RANGE
16	87	40 - 150

TABLE 5. ADDITION RATES OF VITAMIN-MINERAL PREMIXES COMPARED TO MANUFACTURERS' RECOMMENDATIONS

NO. PRODUCERS	ADDITION RATE (% OF RECOMMENDED RATE)	
	AVERAGE	RANGE
24	107	55- 175

TABLE 6. NUTRIENT CONTENT OF THIRTY GROWER FEEDS SAMPLES

	AVERAGE	RANGE
CRUDE PROTEIN (%)	16.6	11.9 - 20.4
CALCIUM (%)	0.88	0.48 - 2.01
PHOSPHOROUS (%)	0.73	0.56 - 1.13
CA:P RATIO	1.19:1	0.79:1 - 1.78:1
DRY MATTER (%)	87.8	83.6 - 92.9

. . . /15

TABLE 7. NUTRIENT CONTENTS OF THIRTY GROWER FEEDS COMPARED TO NRC MINIMUMS

NUTRIENT	NRC MINIMUM	DEVIATION FROM NRC (%)				
		<0.80	0.80-0.90	0.90-1.10	1.10-1.20	>1.20
		NO. RATIONS				
CRUDE PROTEIN	16%	2	3	15	6	4
CALCIUM	0.6%	0	2	7	5	16
PHOSPHOROUS	0.5%	0	0	0	6	24
CA:P RATIO	1.20:1	15	5	5	3	2

TABLE 8. DISTRIBUTION OF CALCULATED LYSINE LEVELS IN THIRTY GROWER FEEDS SAMPLED

LYSINE LEVEL (CALCULATED % OF RATION)				
<0.50	0.50-0.60	0.61-0.66	0.67-0.80	>0.80
NO. RATIONS (OUT OF 30)				
0	9	9	11	1

TABLE 9. VARIATION IN NUTRIENT ANALYSES DUE TO SAMPLING SITE

NUTRIENT *	SAMPLING SITE		
	DISCHARGE AUGER	TOP OF PILE	MIDDLE OF PILE
CRUDE PROTEIN (%)	14.2	11.9	19.7
CALCIUM (%)	0.57	0.24	0.93
PHOSPHOROUS (%)	0.56	0.40	1.05
SALT (%)	0.40	0.19	0.46

* VALUES LISTED ARE THE AVERAGE OF TWO SAMPLES TAKEN AT EACH SITE.

NEW FORAGE VARIETIES

K.W. Clark

Plant Science Department

University of Manitoba

Winnipeg, Manitoba

Canada, R3T 2N2

I have been asked to present an update on newly licensed forage cultivars and indicate something of the status of the bloat-free alfalfa research. Since the middle sixties plant breeders in N. America, Europe and Down Under have been attempting to alter the biochemistry of grasses and legumes to result in higher digestible organic matter and a dimunition of deleterious compounds associated with animal health problems, lowered dry matter intake and clinical or sub-clinical weight loss in cattle and sheep. A prime example of this work has been the reduction in alkaloid content in Harding grass (Phalaris tuberosa) and similarly in Reed Canary grass (Phalaris arundinaceae). This latter grass which we grow here, versatile as it is, in its ability to grow on wet land and also withstand drought on generally irrigated land has been the subject of several breeding programs to reduce the alkaloid content. Common Reed Canary grass and the Canadian cultivars Frontier, now deregistered, Grove and Castor contain varying amounts of a number of tryptamane alkaloids along with β-carbolines. Depending on the % level of these compounds ruminants may succumb to nervous disorders, elevated respiration and heart rates and have diarrhoea, weight loss and in the extreme cases death.

Rival R.C.G. licensed in December 1985 is a synthetic cultivar derived from nine clones of diverse geographical origin, selected on the basis of being tryptamine alkaloid free and β-carboline free and having relatively low total alkaloid content referring to the content of hordenine and gramine, two alkaloid-like compounds. Using selections from a seed retention line of R.C.G. from C.D.A. Saskatoon we were able to synthesize a cultivar that has forage yield equal to the licensed cultivars and also have somewhat better seed yield in the hope that seed costs to the farmer could be reduced somewhat from the current $11/kg.

Our breeders seed fields are in W. Manitoba and seed distribution is through SECAN with Brett-Young having an exclusive right to produce foundation seed. This is being done here in the Interlake and in Alberta. Vantage, licenced in Canada in 1981, Venture and Palaton are three low-alkaloid cultivars bred by Dr. Bob Kalton of Research Seeds, Iowa. Vantage has been tested in Canada and we expect significant quantities of seed will have been produced this year in the U.S.A. We expect interest to be generated in the use of our Rival R.C.G. along with the promotion of U.S.A. cultivars which are being merchandized by Pioneer Corn Co. and Research Seeds, who already are starting an advertising campaign. Your interest in new cultivars is well founded in that Seed Sales in Canada are valued at $545 million and exports (mainly grass, legume and corn seed) at $45 million. Seed of improved varieties of all crops is the basis for exports of food and feed valued at over $4 billion. Pedigreed seed usage increases annually, as does the trend to greater useage of improved cultivars. Plant Breeders' rights will result in further efforts in plant breeding and advances in biotechnology to produce cultivars supportive of

improved animal performance. In this regard we forsee the transfer of gene-blocks controlling tannin biosynthesis from some bloat-free legume such as Sainfoin or Birdsfoot trefoil to alfalfa genotypes which are winter hardy and drought resistant Canadian cultivars. We expect Canada Agriculture, Saskatoon to continue its work on breeding of a bloat-free alfalfa in conjunction with the N.R.C. Plant Biotechnology Laboratory who have the relevant expertise in biochemistry and protoplast-fusion-tissue culturing techniques to genetically engineer the derivation of such inter-generic hybrids to enable us to eliminate some of the anti-quality components of forage crops. These are the components which are animal performance depressants in a particular forage that in other respects and tests is good quality forage. They may cause poor animal gains, reproduction problems, e.g., oestrogenic compounds in red clovers, toxicity syndromes or poor palatability.

The coumarin content of sweet clovers can fall into the toxicity syndrome category in that with dicoumarol production in mouldy sweet clover hay causing bleeding disease of cattle, can become lethal. C.D.A. Saskatoon have licensed two cultivars to reduce this problem in the use of the valuable biennials of sweet clover. Polara, a white flowered Melilotus alba cultivar was released in 1979, and Norgold, a yellow flowered Melilotus officinales, released in 1981. Both are low in coumarin content. Polara seed is increased exclusively by Sask. Pool Elevators, but Norgold which is higher yielding is a SECAN general release cultivar with seed currently selling at $3.35/kg.

Currently only limited quantities of certified seed of Norgold is available, but here in Manitoba Brett-Young have two foundaton seed

fields in production which should allow the seeding of 300 acrea for certified seed in 1987 and 250 acres in 1988.

It is expected that Norgold will become a more popular, higher demand cultivar. Norgold sweet clover the first low coumarin yellow-flowered cultivar was the culmination of a long-term (22 years) breeding program. This cultivar now will provide the farmer and rancher with a popular sweet clover forage which is completely safe from the hemorrhagic sweet clover bleeding disease of cattle and sheep.

Polara the white flowered type. This particular cultivar is highly prized by the beekeepers. One could suggest that with the use of one of the biennials and the use of mold-preventing bacterial inoculants good quality silage should be ensured.

Returning to further consideration of alfalfa bloat as a continuing problem, there is the viable suggestion that a mixture of Birdsfoot trefoil, alfalfa and appropriate grasses should be recommended for wetter land areas, and Sainfoin-Alfalfa (creeping rooted types should be sown in mixture with dryland grasses. There are currently (X) alfalfa cultivars on our recommended list most with excellent yield, persistance (15-20 years) and many with multiple disease resistance, etc. The dryland types such as Rambler, Roaman, Drylander and Heinrichs have in general slightly higher fibre content so bloat may not be as prevalent in grazing these types but it is still possible.

New superior alfalfa cultivars such as Apica, Minto, Endive and Glory have regrowth rates which can result in overall seasonal production above the standard check varieties. Whilst we strive for high volunteering intake of digestible energy of our forage crops, we also recognize that if protein digestion can be reduced in the rumen,

but attained in the small intestine that overall production of milk, meat and fibre may be enhanced.

Tissue culture techniques and genetic engineering of legumes is giving us the opportunity to enhance denitrogen fixation and also upgrade the amino acid complement of forage legumes. Rumen microbiologists may also assist in engineering bacteria able to digest some of the ligno-protein complexes which currently reduce the digestibility, rate of passage and voluntary intake of many currently used species of grasses and legumes.

Cultivars with improved digestibility also have improved intake, certainly this is so in the case of orchard grass, perennial ryegrass and reed canary grass. The use of early and late maturing cultivars of timothy may also afford an extension in the period of grazing with more consistancy in the quality of forage available. Insufficient attention to management of our pastures with respect to application of required fertilizers, initiation of time of grazing, the severity or intensity of grazing and in fall, the removal of livestock to afford the grass and legume plants an opportunity to synthesize storage carbohydrates in the crown and roots, suggest that we need continuing extension programs to get the message to other livestock producers.

Health Security for Swine Operations

Dr. P. Schneider and Dr. M. Sheridan
South East Veterinary Clinic
Steinbach, Manitoba

December 9, 1986

Health security can be defined as the protection of a swine herd against the introduction of an infectious disease not currently present in the herd.

Within each swine herd there will be certain infectious processes going on and it must be understood that no herd is disease free. There are certain infectious diseases though that are economically significant. These should and can be kept out of the unit if an understanding of the mode of introduction exists. The impact of a new disease may be dramatic. The T.G.E. virus, when introduced to a farrowing unit may kill off all pigs less than two weeks old for a two to three week period, then disappear, never to return. Haemophilis pneumonia may also enter a unit

with disasterous effects in growing and finishing pigs. This respiratory disease may subside, only to return later as environmental, nutritional or stocking density stresses are imposed on the pigs. Finally, a disease such as swine dysentery may enter undetected at first and spread throughout the growing - finishing herd and occasionally the breeding herd. It is a chronic disease that requires continuous medication and is not readily eliminated without de-population or extremely expensive medication programs.

The most likely means of a new infectious agent entering the barn is with purchased pigs. Probably, the most difficult question we have to deal with is "where do I buy breeding stock?". When advising a producer on possible sources, we must not only take into account the health status of the various suppliers of breeding stock, but also his own health status. If a producer has a very unstable health status with numerous flare-ups of respiratory or enteric disease, then purchase from a very "clean" herd could be disasterous. The new pigs, unable to handle the challenge of the purchaser's health status, may die or worse still trigger another flare-up when they get sick. It is not uncommon to see thousands of dollars worth of breeding stock get damaged by sickness or lost by death of culling when introduced to a health status they could not handle. When we help a producer in his choice, we must take into account all factors of housing management and current health status to aid in proper

meshing of the purchased stock into the herd.

In the industry, we hear the term "minimal disease" or "M.D." and "specific pathogen free" or "S.P.F." used to denote health status. The common misconception is that this means disease-free. This error in interpretation can be costly if the producer stocked with one minimal disease source switches to another solely on the basis of the M.D. label. Minimal disease usually means free of clinical diseases such as atrophic rhinitis, haemophilis pneumonia and swine dysentery. The problem is that there are no set definitions at this time for what minimal disease really means. A better term would be "controlled and defined health status". The purebred breeder, breeding company or commercial producer selling gilts that provides some concern for health status will usually be included in the list of potential suppliers given to a client. The final choice is his and will usually be influenced by price, reputation, volume available, genetics and purchase philosophy.

The security of a commercial herd depends to a large extent on the breeder that supplies breeding animals. Before choosing a breeder there are several questions that must be answered.

a) The health reputation of the breeding herd must be questioned. It is often difficult to see disease patterns in a stable herd, especially if

housing techniques do not compare with those of a modern commercial facility. It is wise therefore, to look not only at the health history of the breeder, but also that of herds supplied by that source. This can be done by asking for references and having the veterinarians involved with the herds discuss various health problems.

b) The long-term committment to purchase from a breeder must be made with the confidence that the health status of the supplier is secure. The most easily recognized feature of a breeders concern for health status is his approach to visitors in the herd. Some breeders have a no visitors policy, with strict no pig contact rules for essential personnel such as workers, veterinarians, maintenance people etc. These range from 48 to 96 hours. This may seem ridiculous until you realize that humans can carry disease organisms usually in hair and on skin and clothing from hours to days. Some disease organisms such as the mange mite, Strep suis II or Bordetella bronchiseptica may well be carried by humans. T.G.E. can be readily transferred by boots carrying infected manure. We have seen a case of T.G.E. caused by a salesperson stepping into a producer's office and announcing he could not stay, because the last farm he was at had a major disease problem. The producer then tracked the virus from the office floor to the sows housed just inside the office door. He lost one months worth of baby pigs.

The serious breeder should not only restrict visitors but set a shower in policy and supply clothes and boots for essential visitors.

Viewing areas, though questionable, do supply the purchaser's desire to see the stock pre-purchase. These should be set up so that breeding animals are not at risk from purchasers who may come to the farm without taking any clean-up precautions. Some breeders do not allow any viewing and deliver sight unseen. This is a much more secure system, reducing on farm traffic. It does depend on trust and reputation.

c) The movement of new genetic material into a breeding herd is important. Ideally a breeding herd should not bring in live, mature animals unless it is certain the health status of the herd will not be affected. The use of A.I., caesarian, hysterectomy or embryo transfer are less risky means of bringing in new bloodlines. There are questions associated with the safety of each and these must be weighed in the decision to transfer in genetic material. A.I. has come under some question as to its safety with respect to Leptospirosis and reproductive viruses. The same arguements also surface about C-section or hyterectomy derivation. Embryo transfer may well prove to be the safest means of genetic introduction into "clean" herds.

d) The transportation of breeding stock by a breeder can influence the

health of a commercial herd. If a breeder is delivering to several sources, it is important that off farm, truck to truck transfer occur. Imagine pulling up to a farm to deliver a pig at the barn door. The likelihood of contamination of a second pig from fan exhaust, dirty loading ramps and dirty boots of who ever stepped into the box to push off the first pig is high. The pig delivered next may well carry a completely different load of infectious agents. If the second herd is free of these, then health problems could follow. The arguement that farm A is cleaner that farm B is not valid as often perception is different than reality. Veterinarians would probably not feel comfortable deciding who was cleaner than who in such a situation.

The delivery truck should be washed and disinfected after each delivery, not only to protect the next client, but also to protect the supplier's herd when the truck returns to re-load. Off farm truck to truck delivery helps protect the delivery truck from excessive contamination.

e) The handling of slaughter animals is also important. The slaughter truck should be cleaned and disinfected after every load. Swine dysentery, T.G.E. or Salmonella would be dangerous infectious agents picked up at a hog commission, slaughter plant or auction mart yard. The use of one truck for slaughter pigs and one for breeding stock makes the most sense. Remember that disease organisms live longer in cold and damp

or frozen states than in hot and dry conditions. This means that proper washing and disinfection of vehicles is most important at those times when it is the most difficult to do so.

If a breedeer uses a commercial transfer to remove slaughter pigs, then that truck should arrive clean and disinfected. It preferably should arrive after a weekend off, or at least after hauling cattle. It should never arrive with other pigs aboard, as they could redily contaminate the herd while backed up for loading.

f) The use of test stations and public auction of breeding stock is part of the industry. It is questionable if these should be a forum for breeding stock sales given the cross-contamination from several herds. The breeder chosen to supply commercial herds should be questioned as to whether these animals ever return to the farm, or if animals are purchased from such sales. Such practices reduce the confidence that their health status is secure.

g) Practices such as the purchase of grain and feed may be questioned if dealing with very clean health status herds. The cleaner the health status of a herd the more careful the breeder must be about purchasing manure contaminated grains, hauled by pig farmers in dirty trucks. The use of meat meal, or the hauling of meat meal by feed mills in trucks

destined to haul feed to these herds must also be addressed, especially with reference to Salmonella and perhaps Campylobacter infections.

h) Finally the location of the breeding herd is important with respect to infections transferred from other nearby pig farms. Windborne transfer of Mycoplasma hyopneumoniae infections have been referenced by Goodwin in England. He feels a herd is not secure against such transfer under 2 kilometres from another infected pig farm.

The proximity to other farms allows for the night-time movement of cats. Tom cats are reported to have routine night circuits that take them on journies up to 3 miles in total. These wandering cats can act as mechanical vectors for a whole host of infectious agents including T.G.E and E. coli.

The migration of rats can bring in diseases such as Samonellosis, Leptospirosis and even Swine Dysentery.

The farm dog can easily drag home carcasses from the neighbour's dead pile and with them the diseases that killed them.

The very security practices demanded of a breeder should also be practiced by the commercial herd. The health status of the commercial

herd may already be established or may be in the planning stage. It is best once a health status is established, that it be stabilized. Even if a herd has had every disease in the book, efforts to keep it stable are important. Purchase from a single source is best, and if not possible, then from as few sources as is possible to meet the genetic needs of the herd.

The commercial producer is often advised to run a closed herd system. This may range from setting up an in-house nucleus to perpetuate genetic material to the purchase of boars only. If the breeding stock supplier is careful in all matters of health security, then the closed herd can also include the pyramid systems used by large breeders. A nucleus herd is used for genetic advancement, and the breeding animals are sent out to a multiplier herd for production of crossbred females or males. These animals are then sent to the commercial herd. By following strict health protocol at nucleus and multiplier levels and straight line distribution from multiplier to commercial client using strict safety precautions for transport, an extended closed herd can be established and ensure a safe stable health status.

It is worth noting that within a tightly controlled pyramid system, down stream multipliers can develop their own health status. Floor designs, sanitation procedures and ventilation will all serve to influence the

health profile. Some herds may be noteably under more enteric pressure while others will have respiratory influences that change the presence and activity of different organisms common to both. It is not uncommon to see flare-ups of disease when the two are mixed. That is when the principle of straight-line distribution is broken. If these mild flare-ups are noted mixing sources with similiar but modified health status, imagine the situation when a herd is infected with a serious disease organism.

The key to success for today's commercial producer is in the minimizing of any factors that reduce the productivity of the herd. The risk of a serious disease entering the herd is low if simple common sense pre-cautions are practiced. The purchase of breeding stock is a key decision and must be made based on the best historical and current health data available on a potential source.

The trend to the F1 hybrid gilt and terminal sire boar has led some people to try and set up their own mini-nucleus within their own herd. The large commercial producer though cannot afford the time and effort required to make judgements on genetic improvement so must turn to those who can. The choice must be made to minimize the number of sources required to supply the replacements needed. The commercial producer must not only ensure the supplier guards against disease introduction, but

must ensure his own herd is secure. The reduction of visitors, vermin, pets and the choice of location all serve to influence the maintenance of a known health status. You might not expect the producers of Quebec or Iowa to worry about location when they situate a herd as Goodwin's 2 kilometer separation would never be found. They would choose to live with Mycoplasma but work to keep other diseases out. Here in Western Canada, where density is low, the climate at times harsh and capital costs for facilities high, the need to keep diseases out blends nicely with the ability to. As service personel it is our duty to ensure that our clients are protected against health risks we ourselves may pose, as well as any rash or uninformed decisions they may be intending to make. Nothing must be left to chance. We must know such things as failure to control bird access to grain bins or straw piles might lead to T.G.E. or tuberculosis entering the herd. We must also recognize that all details must be addressed as in the de-population for swine dysentery. Without control of the mice, which carry the disease organisms for up to 100 days, there will certainly be re-infection of the new herd. All aspects of health security are complex, but simply controlled through cautious, common sense approaches.

The commercial producer and the industry must recognize that there are no set definitions of such things as "clean stock" or "minimal disease pigs". The term "registered" does not in any way denote health status.

The use of veterinarians to investigate the health status of potential breeders is not common. This will change though as commercial herds become larger and the risk of disease to economic survival becomes greater.

Finally a word on National Herd Security. The greatest foreign disease risk at present is Pseudorabies from the U.S.A. Currently there are strict quarantine guidelines for the importations of American stock. These guidelines have protected us quite well, to date. Some American veterinarians feel that Pseudorabies virus may be transferred into their herds via corn contaminated on truck boxes also used to haul slaughter hogs. This would be one concern we might have if our clients use imported corn for home ground rations. The other area occasionally discussed is the importation of feeder hogs from the U.S.A. for slaughter only. Given that Pseudorabies can be transferred by respiratory tract excretions, then imagine a truck load of U.S. slaughter hogs at a truck stop parked next to some breeder who is planning to deliver his pigs to a trusting client.

CALCIUM AND PHOSPHORUS LEVELS IN SWINE DIETS

E. T. Kornegay, M.S., Ph.D.
Professor of Animal Science
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

Introduction

Calcium (Ca) and phosphorus (P) continue to be important minerals in swine nutrition because of their joint role in skeletal development and their individual roles in many other physiological functions. Calcium is the most abundant mineral in the body, with 99% of it present in bones (Schuette and Linkswiler, 1984), and phosphorus is the second most abundant mineral with 85% of it present in bone (Harrison, 1984).

Formulation of diets to meet the Ca and P needs of the pig depends upon having accurate requirement data and ingredient information concerning the composition and bioavailability of Ca and P. Current NRC (1979) recommendations are for total Ca and P and were derived primarily from research in which cereal grain - plant protein diets were fed with commonly used supplemental Ca and P sources. During the past decade, a great deal of research has dealt with determining bioavailability of P in cereal grain, protein sources and commonly used P sources, and within the last five years, the bioavailability of Ca in commonly used Ca

---

[1]Prepared for 1986 Manitoba Animal Industry Conference, Dec. 9.

sources. It may now be possible to calculate the actual Ca and P requirement of the pig and to formulate diets based on available Ca and P. A complete review of Ca and P in swine nutrition was recently published (Kornegay, 1986).

Sows and Developing Gilts

The proper level of Ca and P to feed during the various stages of reproduction is still being debated. Early studies from 1929 to 1937 established that diets deficient in Ca and/or P would not support normal reproduction in sows (Kornegay, 1986). Sows fed deficient levels suffered lameness, experienced farrowing difficulty, secreted little milk, and farrowed and weaned small litters. These early researchers concluded that sow diets should include not less than .4% Ca and .33% P. However, it should be noted that the daily feed intake in these early studies was much greater than is generally allowed today, thus the daily intake of Ca and P was not very different from that recommended by NRC (1979).

Most Ca and P research in sows since these early studies has been conducted during the past 10 to 15 years and has dealt with the evaluation of feeding higher Ca and P levels than recommended by NRC (1973, 1979). - believing these higher levels would prevent lameness problems, improve breeding and farrowing problems and extend the life of the sow (Kornegay, 1986). There is only weak evidence (only two of thirteen studies) that breeding, farrowing and longevity of sows are improved by feeding

Ca/P levels above 13.5 or 15 g Ca and 10 or 10.8 g P recommended by NRC (1973, 1979). Sow weight and serum and milk Ca and P content were not changed by feeding higher Ca/P levels. The effect of varying Ca/P levels on various bone criteria (including breaking strength and bone ash) has been inconsistent with increased bone mineralization obtained when a difference was observed. Maxson and Mahan (1986) recently reported that bone mineralization decreased over two or more farrowings for sows nursing average (6 to 7 pigs) and large (11 to 12) litters compared with nongravid control females of the same age with the effect greater (especially for vertebra and rib bone ash) for the high-producing sows. However, feeding elevated Ca/P levels (.65/.5, .78/.6, .91/.7, 1.04/.8 and 1.17/.9% Ca/P) during lactation did not prevent the decrease in bone mineralization.

In a one parity study, gilts fed NRC Ca/P (.65/.5%) from weaning to 92.8 kg were more subject to lameness during gestation than were those fed 150% higher Ca/P when both groups were fed 13 g Ca and 10 g P (approximately NRC for gestation) daily from 92.8 kg to parturition (Nimmo et al., 1981). Feeding a higher Ca/P level (19.5 g Ca and 15 g P) from 92.8 kg to parturition, however, overcame the detrimental effects of the lower Ca/P level fed during growth and development. Farrowing performance was similar for all dietary Ca/P treatments. Other studies (Kornegay, 1986), including a large three-parity cooperative study involving 586 farrowings conducted at five experiment

stations (Kornegay et al., 1985) have indicated that feeding higher than NRC suggested Ca/P levels to gilts during growth and development did not improve their subsequent reproductive performance and longevity when they were housed in confinement and limit-fed a gestation-lactation diet containing .8% Ca and .6% P for multiple farrowings.

Studies in which structural soundness was evaluated have failed to provide any evidence for a cause and effect relationship between bone mineralization (varied by feeding elevated Ca/P levels) and structural soundness (Kornegay, 1986; Brennan and Aherne, 1986).

Although high producing sows have not responded to dietary Ca/P levels above those currently recommended by NRC, the consequence of feeding levels below NRC are more severe for sows than for the other classes of swine, and previously fed Ca/P level, length of lactation, number of farrowings, Ca/P ratio and other nutrient interactions should be carefully evaluated.

Growing and Finishing Swine

Although today pigs are leaner (less backfat) and have a lower feed per gain ratio, average daily gains have not changed greatly during the past several years. Studies reevaluating the Ca-P requirement of modern pigs have generally shown that the NRC (1979)-recommended Ca-P levels are adequate to support maximum growth rate and feed efficiency (Cromwell et al., 1970, 1972; Bayley et al., 1975; Doige et al., 1975; Parker et al., 1975a;

Newman and Elliott, 1976; Pond et al., 1978; Thomas and Kornegay, 1981; Mahan and Cera, 1985). A few studies have shown small increases in daily gain (Allee et al., 1974; Parker et al., 1975b; Thomas and Kornegay, 1981) and feed efficiency (Allee et al., 1974; Fammatre et al., 1977) when higher levels of Ca-P were fed, with the maximum response obtained at a Ca-P level slightly above NRC (1979). Improved daily gain and daily feed intake obtained during the growing period when higher Ca-P levels were fed (Reinhard et al., 1976; Fammatre et al., 1977) were not observed when pigs were fed to market weight (Fammatre et al., 1977) suggesting compensatory growth during the finishing phase of production. The enhancement of growth rate and feed efficiency by elevating Ca-P levels is generally more attributable to dietary P rather than Ca. Although very low and very high levels of Ca severely reduce growth rate and feed efficiency, the detrimental effect is less than with a very low or very high level of P (Combs and Wallace, 1962; Stockland and Blaylock, 1973; Stober et al., 1979; Hall et al., 1985; Reinhart and Mahan, 1985). A wide Ca:P ratio aggravated both situations.

Bone mineralization, as measured by bone ash, bone breaking strength or other parameters, sometimes responds to higher Ca-P levels and usually plateaus at Ca-P levels about 20% higher than those required for maximizing feedlot performance (Reinhard et al., 1976; Fammatre et al., 1977; Mahan et al., 1980; Maxson and Mahan, 1983; Ross et al., 1984). However some studies have

reported a similar response for feedlot performance and bone mineralization (Cromwell et al., 1970, 1972; Parker et al., 1975a; Thomas and Kornegay, 1981; Kornegay and Thomas 1981; Prince et al., 1984).

Only a very weak line of evidence suggest that gilts (similar to boars) require a slightly higher Ca-P level to maximize growth than do barrows (Thomas and Kornegay, 1981; Cromwell et al., 1970). Depressed feedlot performance and bone mineralization have been observed for barrows and gilts fed diets containing inadequate P (Cromwell et al., 1970; Bayley et al., 1975; Newman and Elliott, 1976; Thomas and Kornegay, 1981).

Two data sets were prepared from the available studies since 1969 (table 1). Data from studies in which the Ca-P level fed during the growing phase was reduced during the finishing phase were used to make one data set (reducing Ca-P levels). Data from studies in which the Ca-P level fed during the growing phase was continued during the finishing phase were used to make the other data set (continuous Ca-P levels). Two performance (daily gain and gain to feed ratio) and two bone parameters (breaking strength and dried fat-free ash) were used for each study if available. Most studies had performance data, but all studies did not have both bone breaking strength and bone ash. There was some variation in the bones used in the various studies, but only data for bones known to be sensitive to dietary Ca-P levels were included in the table. The Ca-P levels in each study were

expressed as a percentage of NRC (1973) recommended levels (.65/.5 and .5/.4% Ca/P in the growing and finishing phases, respectively). In the more recent NRC (1979), an intermediate level of Ca-P was added (.55/.45%, Ca/P).

A response curve to dietary Ca-P levels (expressed as a percentage of NRC levels) was fitted for each parameter in each data set using asymptotic regression (figures 1 and 2). Coefficients for these asymptotic curves are shown in table 2. In order to remove differences among studies (or experiment where there was more than one experiment in a study), performance and bone data obtained for the different Ca-P levels were expressed as a percentage of the NRC 100% value for that parameter in that study (or experiment). Using the equation generated for each of the parameters, the predicted Ca-P level, expressed as a percentage of NRC-recommended levels, was calculated for 97, 98, and 99% of the maximum response (table 3).

When reducing Ca-P levels were fed, 97% of the maximum response was obtained for daily gain, gain to feed ratio and bone ash when 101, 93, and 100%, respectively, of NRC recommended Ca-P levels were fed. To obtain 97% of the maximum response for breaking strength, 128% of NRC Ca-P levels was required. To obtain 99% of the maximum response, 133% of NRC Ca-P would be required for daily gain, 130% for gain to feed ratio, 148% for bone ash and 151% for bone breaking strength.

However, when Ca-P levels fed during the growing phase were continued during the finishing phase, a much lower Ca-P levels was required to obtain 97, 98, or 99% of the maximum response for all parameters. Ninety-nine percent of the maximum was obtained with 88, 71, 103, and 108% of NRC Ca-P levels, respectively, for daily gain, gain to feed ratio, bone breaking strength, and bone ash. A NRC dietary Ca-P level fed during the growing phase which is continued during the finishing phase is about 25% higher than the recommended Ca-P level for finishing hogs. If a continuous dietary Ca-P level is fed, 97% of the maximum response can be obtained with 71 to 91% of the NRC-recommended Ca-P level for growing hogs.

In summary, based on predicted values obtained from asymptotic regression analysis of available data, 97 to 98% of maximum response can be obtained for daily gain, feed efficiency and bone ash when NRC-recommended Ca-P levels are fed. A higher NRC Ca-P level (about 128%) would be required for 97% of maximum response for bone strength; however, there is no evidence that this level of response is necessary or desirable for bone parameters. NRC Ca-P levels would produce about 88% of maximum response for breaking strength. Thus, present reducing NRC (1979) Ca-P levels appear to be adequate for growing-finishing pigs. If a single Ca-P level is fed during the growing and finishing phase, then about 80 to 85% of NRC Ca-P levels would be adequate to obtain about 97% of maximum response.

Growing Boars

Although several researchers have suggested that boars - which normally grow faster, consume less feed per unit of gain, and are leaner than barrows or gilts - require a higher dietary level of Ca and P (Cromwell, 1978; Moser, 1978; Nimmo et al., 1981). However, Kornegay (1986) reported little difference in the response of boars and growing-finishing hogs. Thus, the current NRC Ca-P level recommended for growing-finishing hogs would produce 97 to 99% maximum response for daily gain, gain to feed ratio, and bone ash in growing-developing boars and about 70 to 90% of maximum response for bone breaking strength.

Bioavailability of Calcium and Phosphorus

Cereal grain and most plant protein sources are quite low in Ca; therefore, most of the pig's Ca requirement is met by supplemental Ca. A substantial proportion of the supplemental Ca may come from inorganic P sources which are commonly used to supply needed P. The balance of supplemental Ca is normally supplied by a high Ca limestone source.

Researchers at the University of Kentucky (Ross et al., 1984; Cromwell et al., 1984) using a single point assay system (slope-ratio technique) estimated the relative bioavailability of Ca in several Cu supplements to be high (figure 3). Ca in dehydrated alfalfa meal was much less available.

With the exception of a few sources, P in most inorganic P sources is highly available. Although a few reports suggest that

defluorinated phosphate is slightly less available than dicalcium phosphate (Plumlee et al., 1958; Noland et al., 1971), other, more recent reports, show no difference (Harmon et al., 1974a; Partridge 1981; Kornegay et al., 1984). Lower P availability has been reported for soft phosphate with colloidal clay (Chapman et al., 1955; Plumlee et al., 1958; Harmon et al., 1970b; Harmon et al., 1974a). In addition to its poor P availability, soft phosphate has a high fluorine content which could cause toxicity problems. When fed to sows, Curacao Island phosphate showed P availability equal to that of dicalcium phosphate (Harmon et al., 1974b) but Curacao Island phosphorus was slightly less available for growing pigs fed a very low P basal diet (Plumlee et al., 1958). Phosphorus in steamed bone meal appears to be equally available to that in dicalcium phosphate and defluorinated phosphate (Chapman et al., 1955; Plumlee et al., 1958). Phosphorus in fertilizer grade super phosphate is equally available to P in dicalcium or defluorinated phosphate (Prochazka et al., 1972a,b), but contains a high level of fluorine. The P bioavailability, Ca content, and F content must all be considered when choosing a phosphate source.

The bioavailability of P in most plant feedstuffs is low (10 to 40%) compared with most inorganic sources of supplemental P (Kornegay, 1986). This poor availability is believed to be due primarily to the high phytin phosphate portion of the total P.

Calcium-Phosphorus Ratio and Other Factors

High levels of Ca and P are usually considered not to be toxic in the same way that high levels of some of the trace minerals are, but a high level of either Ca or P reduces the efficiency of the other and can also reduce the utilization of minerals and nutrients.

Because of the relatively high price of P and the low price of Ca, there is a tendency to feed excess Ca and to feed P to barely meet the needs of the animals. The Ca to P ratio is an important consideration when swine diets are being formulated since a ratio which is too wide may adversely growth rate, feed efficiency, and bone development (Calvert et al., 1978) while a ratio too narrow may result in bone resorption (Doige et al., 1975).

The importance of maintaining a proper Ca:P ratio is more critical if the Ca or P level is marginal or inadequate. Much higher levels of Ca or P can be fed without reducing performance if a proper ratio of Ca:P is maintained.

In their reviews, both Peo (1976) and Hays (1976) concluded that a Ca:P ratio of approximately 1.2:1 or 1.3:1 should result in maximum skeletal development and performance. They also suggested that this ratio should not exceed 1.6:1. This conclusion has been substantiated by Doige et al. (1975), Hsu et al. (1976), van Kempen (1976), Stober et al. (1979) Cromwell (1979), Hall et al. (1985), and Reinhart and Mahan (1985).

Although the Ca:P ratio must be considered in assessing the adequacy of the swine diet, Wasserman (1960) emphasizes that one should be cognizant of the absolute levels of minerals in the diet. The availability of Ca and P, especially P, must be considered in determining the absolute levels. Also, an adequate amount of vitamin D is essential (Miller et al., 1965a,b).

In addition to the Ca-P ratio, certain other factors, however, which could influence the response to Ca-P need to be considered when determining the exact Ca-P level to feed. For example, a high level of protein may increase the optimal level of Ca-P (Fammatre et al., 1977). Several interactions should be considered when determining the Ca-P level for the various classes of pigs. High levels of Ca can interfere with utilization of zinc and vitamin K. High dietary fat, fiber and protein levels can increase the Ca-P needs of pigs. A very low level and a very high level of vitamin D will reduce bone mineralization.

References

Allee, G. L., B. A. Koch and R. H. Hines. 1974. Phosphorus levels for growing and finishing swine. Kansas State Univ. Swine Industry Day. p 9.

Arthur, R. D., H. H. Hodson, Jr. and D. S. Gutierrez. 1980. Effect of Ca and P levels in performance and bone characteristics in growing and finishing swine. J. Anim. Sci. 52(Suppl. 1):183.

Bayley, H. S. and R. G. Thomson. 1969. Phosphorus requirements of growing pigs and effect of steam pelleting on phosphorus availability. J. Anim. Sci. 28:484-491.

Bayley, H. S., D. Arthur, G. H. Bowman, J. Pos and R. G. Thomson. 1975. Influence of dietary phosphorus level on growth and bone development in boars and gilts. J. Anim. Sci. 40:864-870.

Brennan, J. J. and F. X. Aherne. 1986. Effect of dietary calcium and phosphorus levels on performance, bone bending moment and the severity of osteochondrosis and lameness in boars and gilts slaughtered at 100 or 130 kg body weight. Can. J. Anim. Sci. 66:777-790.

Calabotta, D. F., E. T. Kornegay, H. R. Thomas, J. W. Knight, D. R. Notter and H. P. Veit. 1982. Restricted energy intake and elevated calcium and phosphorus intake for gilts during growth. I. Feedlot performance and foot and leg measurements and scores during growth. J. Anim. Sci. 54:565-575.

Calvert, C. C., R. J. Besecker, M. P. Plumlee, T. R. Cline and D. M. Forsyth. 1978. Apparent digestibility of phosphorus in barley and corn for growing swine. J. Anim. Sci. 47:420-426.

Chapman, H. L. Jr., J. Kastelic, G. C. Ashton and D. V. Catron. 1955. A comparison of phosphorus from different sources for growing and finishing swine. J. Anim. Sci. 14:1073-1085.

Combs, G. E. and H. D. Wallace. 1962. Growth and digestibility studies with young pigs fed various levels and sources of calcium. J. Anim. Sci. 21:734-737.

Cromwell, G. L. 1978. Ca and P make the difference. Hog Farm Manage., June, p. 36.

Cromwell, G. L. 1979. Recent advances in mineral nutrition of swine. Feed Manage., March, p 30-35.

Cromwell, G. L., V. W. Hays, C. H. Chaney and J. R. Overfield. 1970. Effects of dietary phosphorus and calcium level on performance, bone mineralization and carcass characteristics of swine. J. Anim. Sci. 30:519-525.

Cromwell, G. L., V. W. Hays, C. W. Scherer and J. R. Overfield. 1972. Effects of dietary calcium and phosphorus on performance and carcass, metacarpal and turbinate characteristics of swine. J. Anim. Sci. 34:746-751.

Cromwell, G. L., R. D. Ross and T. S. Stahly. 1984. Bioavailability of calcium in feed ingredients for swine. Feed Manage. 35(9):23-32.

Doige, C. E., B. D. Owen and J. H. L. Mills. 1975. Influence of calcium and phosphorus on growth and skeletal development of growing swine. Can. J. Anim. Sci. 55:147-164.

Fammatre, C. A., D. C. Mahan, A. W. Fetter, A. P. Grifo, Jr. and J. K. Judy. 1977. Effects of dietary protein, calcium, and phosphorus level for growing and finishing swine. J. Anim. Sci. 44:65-71.

Hall, D. D., G. L. Cromwell and T. S. Stahly. 1985. Hemorrhagic syndrome induced by high dietary calcium levels in growing pigs. J. Anim. Sci. 61(Suppl. 1):319.

Harmon, B. G., A. H. Jensen and D. H. Baker. 1970b. Effect of pelleting on phosphorus utilization in swine. J. Anim. Sci. 31:202 (Abstr.)

Harmon, B. G., C. T. Liu, S. G. Cornelius, J. E. Pettigrew, D. H. Baker and A. H. Jensen. 1974a. Efficacy of different phosphorus supplements for sows during gestation and lactation. J. Anim. Sci. 39:1117-1122.

Harmon, B. G., S. G. Cornelius, D. H. Baker and A. H. Jensen. 1974b. Efficacy of defluorinated phosphate as a supplement in swine rations. J. Anim. Sci. 39:182-183 (Abstr.).

Harrison, H. E. 1984. Phosphorus. In Present Knowledge in Nutrition, Fifth Ed. The Nutrition Foundation, Inc., Washington, D.C.

Hays, V. W. 1976. Literature review on phosphorus in swine nutrition. National Feed Ingredients Association, 60 pp.

Hsu, J. C., G. L. Allee and B. A. Koch. 1976. Femur and phalange bones as indicators of dietary deficiency. Kansas State University, Swine Day Rep. p 19.

Irlam, D., H. H. Hodson, Jr. and R. Snyder. 1975. Effect of sex and type of pig on calcium and phosphorus requirement. Southern Illinois Swine Rep. p. 41.

Kornegay, E. T. 1986. Calcium and Phosphorus Nutrition in Swine, in Calcium and Phosphorus in Animal Nutrition, National Feed Ingredient Association, Des Moines, IA, 109 pp.

Kornegay, E. T. and H. R. Thomas. 1981. Phosphorus in swine. II. Influence of dietary calcium and phosphorus levels and growth rate on serum minerals, soundness scores and bone development in barrows, gilts and boars. J. Anim. Sci. 52:1049-1059.

Kornegay, E. T., B. G. Diggs, O. M. Hale, D. L. Handlin, J. P. Hitchcock and R. A. Barczewski. 1985. Reproductive performance of sows fed elevated calcium and phosphorus levels during growth and development. J. Anim. Sci. 61:1460-1466.

Kornegay, E. T., M. D. Lindemann, H. S. Bartlett and J. L. Baker. 1984. Bone mineralization and feedlot performance of finishing swine fed two levels of sodium with two phosphorus sources. VPI&SU, Anim. Sci. Livest. Res. Rep. 3:1-9.

Libal, G. W., E. R. Peo, Jr., R. P. Andrews and P. E. Vipperman, Jr. 1969. Levels of calcium and phosphorus for growing finishing swine. J. Anim. Sci. 28:331-335.

Mahan, D. C. and K. R. Cera. 1985. Effect of various dietary Ca and P sequences on growing-finishing swine performance and leg soundness measurements. J. Anim. Sci. 60 (Suppl. 1):87.

Mahan, D. C., K. E. Ekstrom and A. W. Fetter. 1980. Effect of dietary protein, calcium and phosphorus for swine from 7 to 20 kg body weight. J. Anim. Sci. 50:309-314.

Maxson, P. F. and D. C. Mahan. 1983. Dietary calcium and phosphorus levels for growing swine from 18 to 57 kilograms body weight. J. Anim. Sci. 56:1124-1134.

Maxson, P. F. and D. C. Mahan. 1986. Dietary calcium and phosphorus for lactating swine at high and average production levels. J. Anim. Sci. 63:1163-1172.

Miller, E. R., D. E. Ullrey, C. L. Zutaut, J. A. Hoefer and R. W. Luecke. 1965a. Comparisons of casein and soy proteins upon mineral balance and vitamin D2 requirements of the baby pig. J. Nutr. 85:347-354.

Miller, E. R., D. E. Ullrey, C. L. Zutaut, J. A. Hoefer and R. W. Luecke. 1965b. Mineral balance studies with the baby pig: Effects of dietary vitamin D2 level upon calcium, phosphorus and magnesium balance. J. Nutr. 85:255-259.

Moser, B. 1978. Boars may need more calcium and phosphorus that NRC says. Feedstuffs, Aug. 28, 1978.

Newman, C. W. and D. O. Elliott. 1976. Source and level of phophorus for growing-finishing swine. J. Anim. Sci. 42:92-98.

Nimmo, R. D., E. R. Peo, Jr., J. D. Crenshaw, B. D. Moser and A. J. Lewis. 1981. Effect of level of dietary calcium-phosphorus during growth and gestation on calcium and phosphorus balance and reproductive performance of first-litter sows. J. Anim. Sci. 52:1343-1349.

Noland, P. R., C. A. Baugus, R. N. Sharp and Z. Johnson. 1971. Sources of phosphorus for growing pigs. Arkansas Farm Res. 20(4):10.

NRC. 1973. Nutrient Requirements of Domestic Animals, No. 2 Nutrient Requirements of Swine. Seventh Revised Ed. National Academy of Sciences - National Research Council. Washington, DC.

NRC. 1979. Nutrient Requirements of Domestic Animals, No. 2. Nutrient Requirements of Swine. Eighth Revised Ed. National Academy of Sciences - National Research Council. Washington, D.C.

Parker, G. R., G. L. Cromwell and V. W. Hays. 1975a. Evaluation of phosphorus levels, exercise and dirt in the diet on performance and bone traits of G-F swine. J. Anim. Sci. 41:324-325 (Abstr.).

Parker, G. R., T. J. Prince, G. L. Cromwell, V. W. Hayes and D. D. Kratzer. 1975b. Effects of Ca-P and Cu levels on performance and bone traits of G-F swine. J. Anim. Sci. 41:325 (Abstr.).

Partridge, I. G. 1981. A comparison of defluorinated rock phosphate and dicalcium phosphate, in diets containing either skim milk powder or soya bean meal as the main protein supplement, for early-weaned pigs. Anim. Prod. 32:67-73.

Peo, E. R., Jr. 1976. Literature review on calcium in swine nutrition. National Feed Ingredients Association, 65 pp.

Plumlee, M. P., C. E. Jordan, M. H. Kennington and W. M. Beeson. 1958. Availability of the phosphorus from various phosphate materials for swine. J. Anim. Sci. 14:73-88.

Pond, W. G., E. F. Walker, Jr. and D. Kirtland. 1975. Weight gain, feed utilization and bone and liver mineral composition of pigs fed high or normal Ca-P diets from weaning to slaughter weight. J. Anim. Sci. 41:1053-1056.

Pond, W. G., E. F. Walker, Jr. and D. Kirtland. 1978. Effect of dietary Ca and P levels from 40 to 100 kg body weight gain and bone and soft tissue mineral concentrations. J. Anim. Sci. 46:686-691.

Prince, T. J., V. W. Hays and G. L. Cromwell. 1984. Interactive effects of dietary calcium phosphorus and copper on performance and liver copper stores of pigs. J. Anim. Sci. 58:356-361.

Prochazka, Z., M. Cupak and V. Jambor. 1972b. A comparative study on the utilization of phosphorus by pigs from various phosphates using oral and intraperitoneal administration of ^{32}P. Zb. Vet. Med. 19:726-735.

Prochazka, Z., M. Cupak and V. Jambor. 1972a. The utilization and distribution of phosphorus after peroral administration of P-labeled phosphorus compounds in pigs. Acta. Vet. Brno. 41:263-270.

Reinhard, Mary K., D. C. Mahan, B. L. Workman, J. H. Cline, A. W. Fetter and A. P. Grifo, Jr. 1976. Effect of increasing dietary protein level, calcium and phosphorus on feedlot performance, bone mineralization and serum mineral values with growing swine. J. Anim. Sci. 43:770-780.

Reinhart, G. A. and D. C. Mahan. 1985. Effect of Ca:P ratio at different dietary P levels on performance and bone measurements with starter, grower and finisher swine. J. Anim. Sci. 61(Suppl. 1):298.

Ross, R. D., G. L. Cromwell and T. S. Stahly. 1984. Effects of source and particle size on the biological availability of calcium in calcium supplements for growing pigs. J. Anim. Sci. 59:125-134.

Schuette, S. A. and H. M. Linkswiler. 1984. Calcium: In Present Knowledge in Nutrition, Fifth Ed. The Nutrition Foundation, Inc. Washington, D.C., p. 400-412.

Stober, C. S., G. L. Cromwell and T. S. Stahly. 1979. Availability of phosphorus in corn and barley for the pig. J. Anim. Sci. 49(Suppl. 1): 97-98.

Stockland, W. L. and L. G. Blaylock. 1973. Influence of dietary calcium and phosphorus levels on the performance and bone characteristics of growing-finishing swine. J. Anim. Sci. 37:906-912.

Stone, B. A. and C. H. McIntosh. 1977. The influence of calcium, phosphorus and vitamin D supplementation of a pea-barley ration for growing pigs. Aust. J. Agri. Res. 28:543-550.

Thomas, H. R. and E. T. Kornegay. 1981. Phosphorus in swine. I. Influence of dietary calcium and phosphorus levels and growth rate on feedlot performance in barrows, gilts and boars. J. Anim. Sci. 52:1041-1048.

van Kempen, G. J. M., P. van de Kerk and A. H. M. Grimbergen. 1976. The influence of the phosphorus and calcium content of feeds on growth, feed conversion and slaughter quality, and on the chemical, mechanical and histological parameters of the bone tissue of pigs. Neth. J. Agric. Sci. 24:120.

Wasserman, R. H. 1960. Calcium and phosphorus interactions in nutrition and physiology. Fed. Proc. 19:636.

TABLE 1. REFERENCES FOR DATA SETS USED IN DERIVING ASYMPTOTIC REGRESSION EQUATIONS FOR GROWING-FINISHING SWINE

Reducing Ca-P levels	Continuous Ca-P levels
Cromwell et al. (1970)	Bayley and Thomson (1969)
Cromwell et al. (1972)	Libal et al. (1969)
Doige et al. (1975)	Bayley et al. (1975b)
Parker et al. (1975b)	Irlam et al. (1975)
Pond et al. (1975)	Parker et al. (1975a)
Newman and Elliott (1976)	Hsu et al. (1976)
Fammatre et al. (1977)	Stone and McIntosh (1977)
Arthur et al. (1980)	Prince et al. (1984)
Kornegay and Thomas (1981)	
Thomas and Kornegay (1981)	
Calabotta et al. (1982)	

TABLE 2. COEFFICIENTS FOR ASYMPTOTIC REGRESSION OF DAILY GAIN, GAIN:FEED RATIO, BONE BREAKING STRENGTH AND BONE ASH ON CALCIUM:PHOSPHORUS LEVELS EXPRESSED AS A PERCENTAGE OF NRC RECOMMENDED LEVELS FOR GROWING-FINISHING PIGS

	Starting Ca-P level % NRC	Coefficients[a]			
		A	Y_o	C	R^2
Growing-finishing pigs, reducing Ca-P level					
Daily gain	50	102.2	85.4	.0336	.52
Gain:feed ratio	50	101.7	90.1	.0312	.46
Breaking strength	75	113.2	70.6	.0477	.88
Bone ash	75	102.2	92.3	.0233	.49
Growing-finishing pigs, continuous Ca-P level					
Daily gain	70	101.3	81.8	.1648	.62
Gain:feed ratio	70	99.9	85.4	2.0350	.70
Breaking strength	78	101.1	91.4	.0923	.48
Bone ash	70	101.7	92.8	.0573	.81

[a] $X = A - (A-Y_o)e^{-C \cdot NRC}$. Where X = response as a percentage of that obtained at 100% of NRC Ca-P level; A = maximum response; Y_o = percent of maximum response obtained at starting point of data set; C = relative rate of increase in the response variable; NRC = Ca-P level expressed as percent of NRC recommended levels.

TABLE 3. PREDICTED CA-P LEVEL, EXPRESSED AS A PERCENTAGE OF NRC RECOMMENDED LEVELS, WHICH PRODUCES 97, 98 AND 99 PERCENT OF MAXIMUM RESPONSE FOR GROWING-FINISHING PIGS

Item	Percent of Maximum Response[a]		
	97	98	99
Growing-finishing hogs, reducing Ca-P level			
Daily gain	101	113	133
Gain:feed ratio	93	106	130
Breaking strength	128	137	151
Bone ash	100	118	148
Growing-finishing hogs, continuous Ca-P level			
Daily gain	81	84	88
Gain:feed ratio	71	71	71
Breaking strength	91	95	103
Bone ash	89	96	108

[a]Calculation based on response (X) equation, $X = A - (A-Y_o)e^{-C \cdot NRC}$, using coefficients presented in table 5.

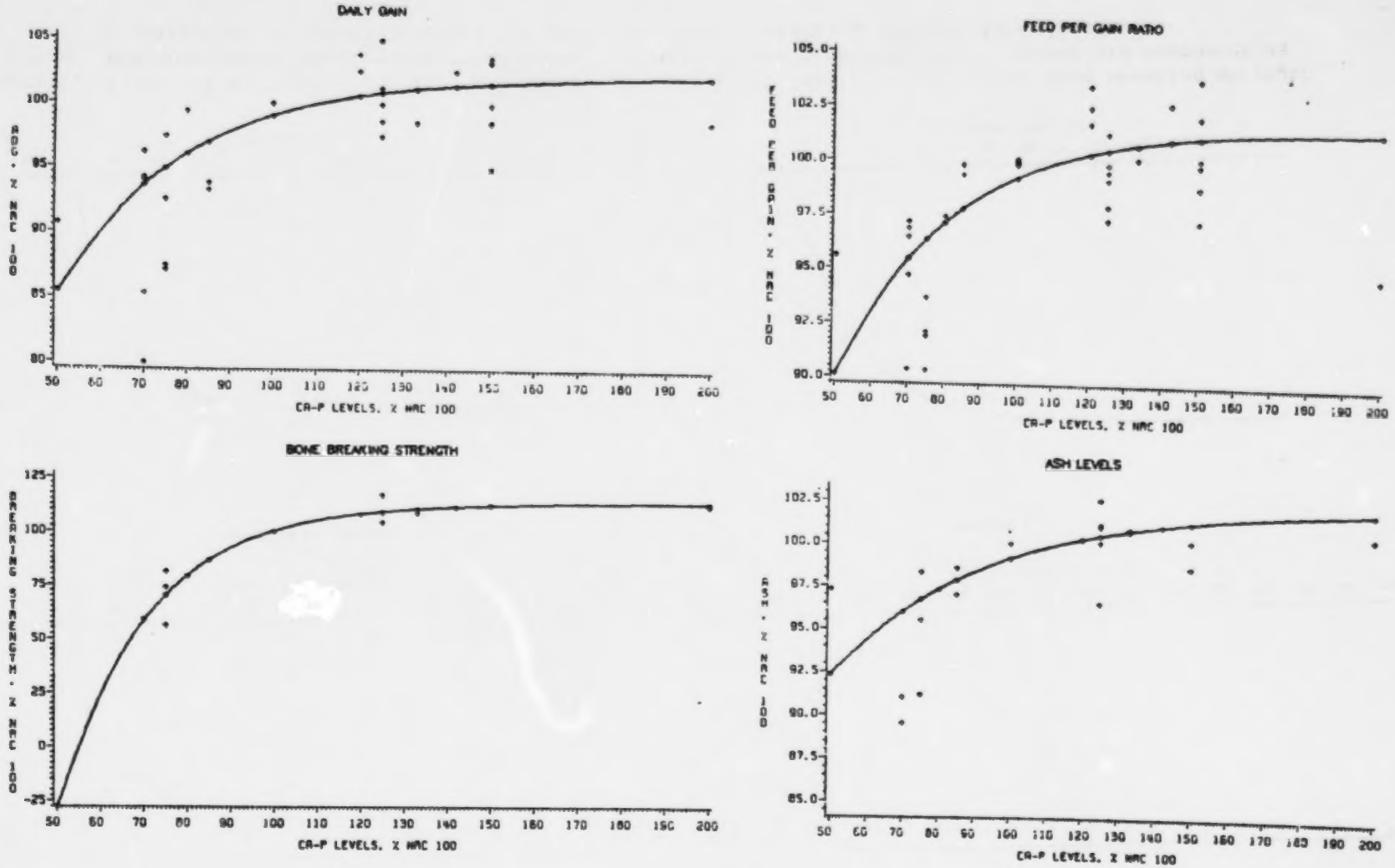

DAILY GAIN
DAILY GAIN, % NRC 100
CA-P LEVELS, % NRC 100
FEED PER GAIN RATIO
FEED PER GAIN, % NRC 100
CA-P LEVELS, % NRC 100
BONE BREAKING STRENGTH
BREAKING STRENGTH, % NRC 100
CA-P LEVELS, % NRC 100
ASH LEVELS
ASH, % NRC 100
CA-P LEVELS, % NRC 100

Figure 1. Effect of reducing dietary Ca-P levels on daily gain, feed per gain ratio, bone breaking strength and bone ash of growing-finishing swine. Actual (+) and predicted (*--*) values are expressed as a percentage of values obtained for swine fed diets containing 100% NRC Ca-P levels.

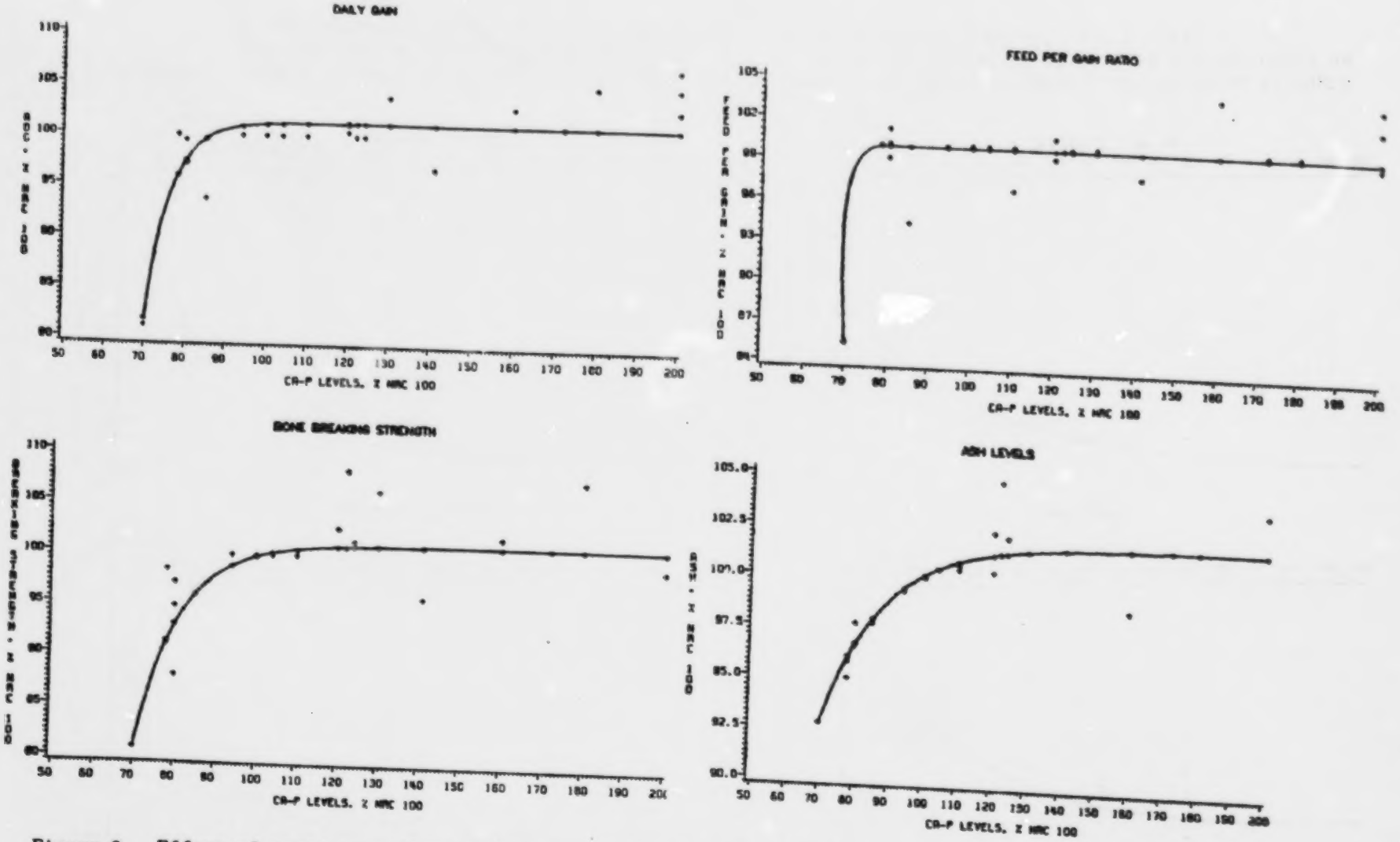


Figure 2. Effect of continuous dietary Ca-P levels on daily gain, feed per gain ratio, bone breaking strength and bone ash of growing-finishing swine. Actual (+) and predicted (*--*) values are expressed as a percentage of values obtained for swine fed diets containing 100% NRC Ca-P levels.

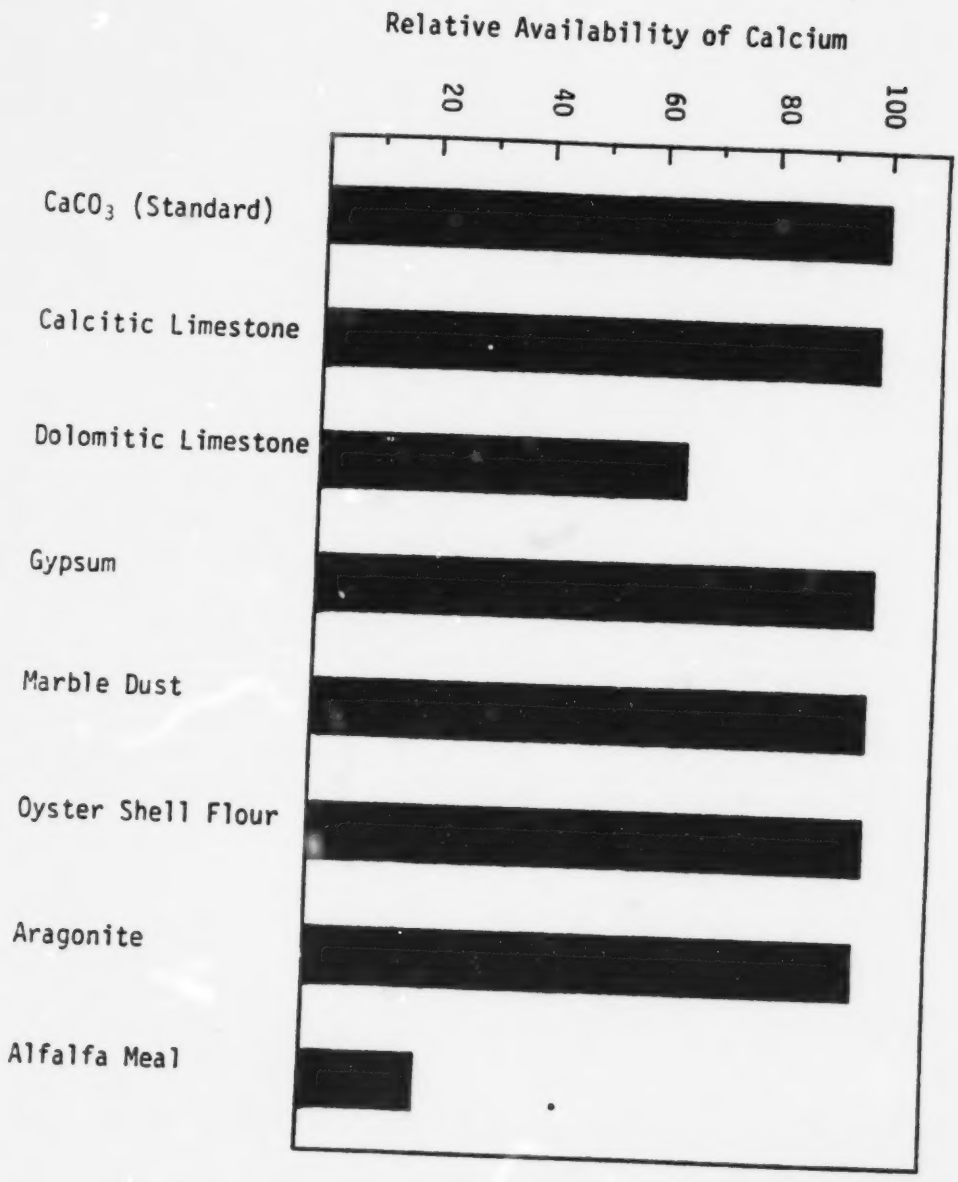


Figure 3. Relative bioavailability of the calcium in calcium supplements and alfalfa meal for the growing pig (10).

Horn Fly Resistance to Pyrethroid Insecticides in Ear Tags

T.D. Galloway
Dept. of Entomology, University of Manitoba

The horn fly was first introduced into North America in the late 1800's and spread rapidly throughout the continent, wherever cattle were produced. Both sexes of this small fly feed on blood and bite the host animal repeatedly throughout the day. Irritations from the bites increases stress on the animal with consequent reduction in weight gain potential, reduced milk production, and lower weaning weights in calves. Animals become visibly irritable under horn fly attack and are generally more difficult to handle.

The horn fly has long been recognized by producers as a significant drain on efficient cattle production, and as a consequence, there have been numerous control strategies adopted, and discarded in favour of more effective methods. Earliest attempts included applications of sticky or foul concoctions, none of which gained general acceptance. The use of natural insecticides such as pyrethrum or nicotine based materials were quickly replaced by the early synthetic insecticides such as DDT, lindane and toxophone. These materials became outdated and widespread use of organophosphate insecticides took their place. Most recently the synthetic pyrethroids have been registered for horn fly control and are currently the most widely used group of insecticides.

As you can see, since the 1940's there has been no shortage of toxic chemicals available to combat the horn fly. However, the greatest amount of research has been in the effective application of these compounds. The larvae, which breed in dung pats, have been attacked using oral larvicides in water, feed, and mineral. The adults, however, have been the primary target. Since adult horn flies spend nearly all their time on the animal, the only

requirement is to get the active insecticide on to the cattle. This has been accomplished over the years using sprays, dips, dust bags, oilers and all conceivable variations, both in free choice and forced used applications.

The development of pyrethroid insecticides in combination with polyvinylchloride plastic ear tags, however, has gained the most widespread and rapid acceptance by producers. The insecticidal ear tags contain an insecticide which is highly toxic to horn flies yet exhibits a wide margin of safety to the animal. They are easy to apply, require virtually no maintenance or upkeep, and have proved reliable for season-long horn fly control.

Unfortunately, with the increasing insecticide pressure on horn fly populations, the inevitable happened: resistance to the pyrethroids began to appear. Resistance was first reported in Florida in 1981. By 1982, horn fly resistance had been recognized in Louisiana, Georgia, Mississippi, Alabama, Oklahoma and Kansas, an amazing spread in just one year. By 1984, resistant horn populations were present in Nebraska and in Arkansas and the resistance issue in the United States became the dominant agenda item at all meetings involving researchers studying livestock pests.

But where do we stand in Canada? No one has demonstrated that resistance to pyrethroids exists in any of the provinces as of the fall of 1986. What is the likelihood that resistance will occur in Manitoba, and how soon might it appear? In a recent letter from Emmett Easton at Brookings, South Dakota, he indicated that he had found a 50 fold resistance factor to fenvalerate and permethrin in local horn fly populations. He also informed me that R. Meyers has found a 79 fold resistance factor in horn flies from Fort Yates,

North Dakota. So it looks like resistance in Manitoba horn flies may be imminent and it would not seem unreasonable to expect our first cases to appear in the 1987 season.

If we accept this, are there ways in which producers can reduce the likelihood of resistance occurring in Manitoba, or at least limit or slow down its spread? Unfortunately there can be no definitive answer to this question, but specialists in the United States met in 1984, and came up with the following recommendations:

1) Tag at the recommended rate, i.e. one tag per animal for horn fly control.
2) Tag the cattle at the beginning, or just before the beginning of the horn fly season.
3) Remove all ear tags at the end of the season.
3) Insecticides other than pyrethroids may be used as alternates to repeated use of pyrethroid insecticides.

If in fact pyrethroid resistance does become a widespread problem in Manitoba, what might be the consequences and how do we deal with the problem. In the U.S., where producers have been faced with pyrethroid resistance, they have largely abandoned the use of ear tags for horn fly control and have reverted to dust bags or oilers to administer organophosphate insecticides which are still effective. We may be forced to do the same in the future. Many companies are experimenting with combination insecticidal ear tags, i.e. tags containing more than one insecticide, but the effectiveness of these devices remains to be determined.

Mr. Felix Mwangala has begun his Ph.D. program at the University of Manitoba to investigate the possibility of pyrethroid resistance in horn flies. He will be examining baseline levels of susceptibility

in our local populations and determining levels of insecticide required to provide control. Hopefully, we will have some answers in the near future and be in a better position to advise cattle producers in the province. In the meantime, it is critical that if producers suspect that they are not getting acceptable horn fly control using currently registered insecticidal ear tags, they notify their Ag. Rep. immediately or contact me directly at the university of Manitoba (474-6024).

EFFECT OF FUNGAL-CONTAMINATED GRAIN ON THE PERFORMANCE OF DOMESTIC LIVESTOCK

A.A. FROHLICH and R.R. MARQUARDT

Department of Animal Science, University of Manitoba

Winnipeg, Manitoba

R3T 2N2

Farm crops and feed face a multitude of hazards both in the field during storage and en route to the consumer or user. Weather conditions, plant diseases, insects, rodents and fungi to name the principal predators, all contribute to an increase in production cost, and loss in quality of farm products.

Different geographical regions in Canada are characterized as being susceptible to specific fungi (molds), of which there are two general groups - field and storage fungi. In Western Canada, storage fungi that belong to Aspergillus and Penicillium species create the main problem of infestation. This does not mean, however, that this region is free of Fusarium species, a typical fungi that infests the crop while in the field, i.e, over-winter under the snow. The probability of contamination and destruction of the crop by fast growing molds is substantially increased when large quantities of damp grain are harvested during adverse weather conditions or due to modern trends of harvesting and storing grain at a high moisture content, even in air tight harvestors. In one of the experiments performed at the University of Manitoba by Dr. Muir, high moisture wheat (25%) was stored in an air tight silo. After six months of storage, massive mold growth was observed at the top of the

grain with lesser amounts being observed at the bottom of the bin. This example together with the increasing incidents of grain spoilage on the farms indicates that the storage of wet crops can result in a markedly deteriorated and inferior product.

Interest in mold induced deterioration of cereal grains and feeds have centered principally upon the two major problems; contaminations by fungi metabolites (mycotoxins) and their pathological effects on living organisms and losses associated with deterioration in the quality of the grain, manifested by reduced nutrient value and altered organoleptic properties which results in poor animal performance, productivity and reproduction.

Most of the attention during the past two decades has been directed towards the effects of the mycotoxins with little or no research being carried out on nontoxic but mold infested grain. In the light of these observations, a research team headed by Dr. R.R. Marquardt of the Department of Animal Science at the University of Manitoba has received funds from the Natural Sciences and Engineering Research Council of Canada, The Western Grains Research Foundation, and The Economic Regional Development Agreement to study the effects of feeding moldy grains and feeds to livestock. Other members of the team are: Dr A.A. Frohlich, Biochemist; Dr G.D. Phillips, Ruminant Physiologist; Dr. S.C. Stothers, Swine Nutritionist; Dr D. Abramson, Chemist and Dr G. Platford, Plant Pathologist. The research program was undertaken to:

a. Estabish the potential for mold and mycotoxin contamination of Manitoba grain,

b. Produce contaminated grain under controlled laboratory conditions for nutritional studies,

c. Produce mycotoxins for nutritional, toxicological and pharmacokinetic studies,

d. Study the effects of different mycotoxins on the biochemical and pathological changes in domestic livestock,

e. Study the pharmacokinetics of orally and intravenously administered toxins in young calves,

f. Establish the prevalence of ochratoxin in the blood and tissue samples of slaughtered domestic livestock (pigs),

g. Develop methods to improve the nutritional value of moldy grain,

h. Develop methods for toxin analyses and to estimate the degree of mold infestation in grain and diets,

i. Develop methods for the detoxification of mycotoxin containing grain by enzyme treatment, dietary treatment or adsorption, and

j. Study the effects of toxin-containing and toxin-free, mold infested grain on nutrient retention and animal performance.

This presentation is mostly concerned with non-toxic moldy grain and its effect on the performance of domestic livestock (poultry and pigs) and the degree that Western Canadian produced swine are contaminated with ochratoxin.

MYCOLOGICAL EVALUATION: An examination of fresh barley samples collected from granaries in Manitoba showed that in addition to being contaminated with storage fungi, there were considerable concentrations

of spores from field fungi, Alternaria, Rhisopus, Helmintosporium and Fusarium. Among these, special attention should be paid to the Fusarium species. These fungi are known to be responsible for the production of the highly toxic trichothecenes, T-2 toxin and vomitoxin. It had been a previous opinion that the weather conditions in Manitoba prevented fusarium growth. In these studies, fusarium represented approximately 30% of the total mycological population of the barley. Therefore, it should be considered as a third important and potentially dangerous toxin producer besides the two principal storage fungi Penicillium and Aspergillus species. These latter strains are also responsible for the production of several highly toxic mycotoxins such as ochratoxin A, citrinin and sterigmatocystin. However, in many circumstances, in both natural and laboratory conditions, an intensively growing fungal mass is observed but toxins are not formed. Also among the same strains of the same fungal species there is a great variability in degree of toxin production. This is mostly attributed to inherent biological differences among strains. Furthermore, toxin production depends upon temperature, moisture and almost always is parallel to the degree of spore generation by the toxigenic molds. This appears as a characteristic green and/or grey dust frequently called blue mold, and occurs when toxigenic strains are either grown in the laboratory and/or under natural conditions.

SOURCE OF MOLDY GRAIN FOR NUTRITIONAL STUDIES: Under appropriate conditions nontoxigenic strains molds are able to grow rapidly and as a result they utilize valauble nutrients from the substrate (grain). The net effect is that stored grains not only have lost readily metabolizable nutrients but are also spoiled by the mold and the other metabolites that

they produce.

One of our studies involved moldy but toxin-free Bedford barley that was obtained from a local farmer. Mycological examination showed the presence of two predominant strains of fungi, Penicillium cyclopium and Aspergillus flavus. Chemical analyses for fungal mass demonstrated that there was approximately 50 times more chitin (a major mold component) as compared to clean barley (21 and 0.4 mg of chitin per kg of barley, respectively). The intensive vegetative growth of the molds on the barley substrate resulted in a marked reduction in the concentration of essential nutrients. For instance, the starch level was decreased in the moldy barley by 42% and fat by 17%. As a result, the digestible energy level was greatly reduced. The kernels appeared to be an "empty bag" with the final bushel weight being reduced by 43%. The protein content, however increased from 11.7% in the control-clean barley to 20.3% in the moldy barley. There was also an increase in the concentration of acid detergent fiber (ADF) (14.9%) and ash (4%) as compared to values obtained with the control barley which had values of 6.6% and 2.4%, respectively. This barley was used for comparative nutritional studies in three experiments with chicks and two with pigs.

CHICK EXPERIMENTS: The objectives of these experiments were to examine the effects moldy barley (MB) on chick performance and nutrient retention in the absence and presence of ochratoxin A (OA) as influenced by dietary fat. Seven-day old male Leghorn chicks were fed the experimental diets for 14 days.

In the first experiment, the effect of three diets containing different amounts of moldy barley (MB) were examined. The diets

contained 60% clean barley or 15, 30 and 60% moldy barley plus the balance of the barley as clean barley. The feed to gain ratio was markedly affected by the level of MB in the diet. The average body gains per pen per day which were also affected were 117.0, 80.6, 27.8 and 3.4 g respectively, for birds fed the control diet (60% clean barley), 15% MB, 30% MB and 60% MB. Feed consumption followed the feed to gain pattern. These effects may be attributed to changes in efficiency of feed utilization or to decreased palatability caused by the presence of molds in the diets. In the case of the feed to gain ratio, the addition of 30% MB to the diet increased this value from 2.0 to 4.2 which indicates a drastic reduction in efficiency of feed utilization. Nutrient retention values which are in agreement with the growth rate, demonstrated that dry matter and fat values were affected to a considerable degree. Compared with the control diet, the addition of 60% MB reduced dry matter and fat retentions by a factor of two, while protein retention was only slightly affected. These observations provide new and conclusive evidence that poor performance in chicks fed MB is not only a result of reduced feed consumption but also reduced utilization of nutrients.

In the second experiment, graded amounts of MB (15 and 30%) were fed with and without ochratoxin A. The weight gain of the chicks fed the diet with 4 ppm of ochratoxin and 0, 15, 30% graded amounts of MB were 55% lower then those that were fed the same diets without ochratoxin. Feed consumption followed the weight gain pattern. The retention of dry matter, fat and protein were similar to those obtained in the first experiment. Ochratoxin A seemed to have a dramatic effect on the fat retention, and contrary to the diets with MB only, it had a marked effect

on protein retention. This parameter was observed to decrease by 69.5% compared to the control diet and the diets with 15 or 30% MB, all of which had similar protein retention values (83, 80 and 80% respectively).

The objective of the third experiment was to establish if the addition of a high energy substance such as tallow would overcome a part of the negative effect of MB. Two levels of tallow (2 and 10%) were added to the control diet (clean barley) and the diet with 30% MB. The addition of fat to the MB diet did not improve chick performance to a level obtained with the mold-free barley but, nevertheless, did considerably improve chick performance. Total weight gain and feed consumption values were improved 94 and 21%, respectively, while the feed to gain ratio changed from 4.0 to 2.3 when fat in the MB diet was increased from 2 to 10%. The results indicate that although moldy grain markedly decreases animal performance its negative effects can be modified to a considerable degree by changing the composition of the diet.

PIG EXPERIMENTS: The objectives of the first pig experiment were to establish the effects of feeding MB to swine for 28 days (phase 1) on growth rate, feed efficiency and protein (amino acid) digestibility; and to establish the degree of compensatory growth during the following 14 day period when the MB containing diets were replaced with clean barley (phase 2). Three barley-soybean meal diets were formulated. The first was a control diet containing 82% clean barley, the second and third contained 25 and 50% of MB, respectively, plus the balance of the barley as clean barley. The source of MB used for the pig experiments was similar to that used with chicks. Pigs were fed three experimental diets

during a four week period (phase 1) and a regular grower ration during the subsequent two week period (phase 2). When moldy barley (MB) was fed during phase 1 of the experiment, the average daily consumption (kg), average daily gain (kg) and feed/gain ratio (kg/kg) were 1.44, 0.59, 2.44 for treatment 1 (control), 1.21, 0.43, 3.0 for treatment 2 (25% MB) and 0.89, 0.28, 3.61 for treatment 3 (50% MB) respectively. As can be seen, the presence of mold in the feed had an effect on the acceptability of the feed, a significant influence on daily gain and a pronounced effect on efficient feed utilization. Similar results were obtained in the experiments with chicks. When the regular diet (grower) was administered to all of groups, the average final daily gain in phase 2 was 0.86, 1.05, 1.15 kg and the feed consumption on a per pen basis were 9.29, 12.15 and 11.83 kg respectively, for pigs that had been previously fed 0, 25 and 50% MB. These results demonstrate that the growth rate of pigs that had been previously fed the moldy barley accelerated relative to the controls when they were subsequently fed the control diet in the second phase. As a result there were no differences in the final weights of pigs among the three treatment groups at the end of compensatory phase (phase 2). These results suggest that the pigs were able to completely compensate the effects of moldy grain. The results also indicate that the impairment of animal growth was due to decreased palatability of the diet and digestibility of nutrients and that the affect could be overcome by replacing MB with clean barley. Also, it is commonly accepted that the negative effects of the moldy barley can be overcome by diluting it with clean barley. This hypothesis was substantiated in this experiment; i.e., the dilution of clean barley with 25 and 50% MB.

The objective of the second experiment with pigs was to determine if they were able to adapt to the deleterious effects of ochratoxin A (OA). The nine week experiment was divided into three periods (3 weeks each) and there were four treatments (T-1, T-2, T-3 and T-4) each having 8 pigs with an initial body weight of between 12-16 kg. In the first period, treatments T-1 and T-2 received the starter diet while T-3 and T-4 were fed the same diet plus 0.5 parts per million (ppm) of OA. In the second period, pigs from T-1 were again fed the starter diet, T-2 received the diet with 2.5 ppm of OA, T-3 the starter diet and T-4, the diet with 2.5 ppm of OA. In the last period all groups received a OA-free regular grower diet.

Feed consumption and daily gain were significantly reduced in the second period of the study in the treatments where pigs received 2.5 ppm of dietary OA compared to those fed with control diet (T-1). An initial feeding of pigs in period 1 with 0.5 ppm of the toxin (T-4), did not, however, elicit any adaptation to the higher OA dosage in period 2 as is often observed with many toxic compounds. However, when the toxin containing diets were replaced by the regular grower diet (the third experimental period) there was no difference among all four treatments in their final weights suggesting compensatory growth in a manner similar to that obtained with MB.

The results might suggest that the most suitable means of utilizing contaminated grain would be to feed it at a low concentration during the early growth period and then replace the diet with a toxic-free diet in the latter finishing period. This would not only enable the pigs to catch up to those that would have been fed a normal diet but would also

increase efficiency of utilization of the overall diet and would result in partial clearance of the toxin trom the animal itself so that the detrimental effects on humans would be minimized.

OCHRATOXIN A IN BLOOD OF SLAUGHTER PIGS: As indicated previously, OA is produced by storage fungi. When consumed it is readily absorbed from the gastrointestinal tract and bound to serum albumin which not only retards OA elimination but allows it to accumulate in the body. The target organs for OA are the kidneys and liver where serious, irreversible and cumulative pathological changes can occur. OA also has been implicated in hormone and immunological abnormalities. Considering the serious effects not only in pigs but also in humans, together with the presence of the toxin in many of the analysed samples of grain and feed from Manitoba, a survey of the occurrence of OA in the blood of slaughter pigs was initiated in our laboratory. Twelve hundred blood samples that were collected from local sources were analysed for the presence of OA. More than 60% of the blood of pigs appeared to contain OA, most at a very low level. There were a few pigs, however that contained very high levels of OA (0.4% of the total examined population). If such a level occurred in Denmark, the entire carcass would be condemned. If similar legislation was invoked in Canada and if values were extrapolated to all of Canada there would be a considerable number of condemned pigs which would result in the loss of several millions dollars of revenue to the livestock producer. Also human health may be affected by the consumption of OA contaminated meat and meat products. Further research should be carried out to more accurately assess the seriousness of this problem.

SUMMARY:

1. In Manitoba the predominant strains of storage fungi are Penicillium and Aspergillus species,
2. Fungi in the vegetative growth stage usually does not produce toxins while the mature sporulated forms can produse toxins,
3. The main toxins produced by storage fungi in Manitoba are ochratoxin, citrinin (not discussed) and sterigmatocystin (not discussed),
4. Toxin-free, moldy grain has a markedly reduced nutritive value as indicated by reduced bushel weight, starch and fat content,
5. Chick and swine performance are markedly depressed when toxin-free, moldy grain is fed,
6. Performance depression may be attributed to reduced nutrient avilability, but also to the presence of factors that depress appetite,
7. There seems to be a synergistic interaction between the affects of moldy grain and ochratoxin particularly with regards to feed efficiency,
8. Pigs, however, are able to completly compensate for effects of moldy grain or ochratoxin upon removal from the diet, and
9. The blood of 0.4 % of pigs slaugtered in Manitoba in 1986 may have contained a significant concentration of OA which would indicate a high level of OA in certain organs. This would result in serious health problems to people that consume contaminated pork or pork products.

ACKNOWLEDGMENT: The authors would like to thank the Natural Sciences and Engineering Research Council of Canada, the Western Grains Research Foundation, the Agri-food Economic and Regional Development Agreement and University of Manitoba for their financial support.

A SUMMARY OF MANITOBA FEEDLOT PROJECTS

by

W. G. HAPPYCHUK
Agricultural Representative, Vita

One of the most successful extension activities has been the feedlot projects. Since 1982, nine major feedlot projects have been conducted in Manitoba. The locations were as follows:

SUMMARY OF MANITOBA FEEDLOT PROJECTS

NAME	CONTRACTOR	LOCATION	STAFF CONTACT
DELEAU FEEDLOT (1985-88)	OAK LAKE GRASSLAND ASSOCIATION	BOB DELEAU FARM	NORM HAMSTEAD BRANDON
DOUGLAS FEEDLOT PROJECT (1985-88)	MANITOBA BEEF PERFORMANCE ASSOCIATION	DOUGLAS TEST STATION	NORM HAMSTEAD BRANDON
ETHELBERT FEEDLOT PROJECT (1986-89)	DUCK MOUNTAIN GRASSLAND SOCIETY	GREG REHALUK FARM ETHELBERT	LYLE MCNICHOL DAUPHIN
INTERLAKE HEIFER FEEDLOT (1985-87)	INTERLAKE LIVESTOCK FORAGE IMPROVEMENT ASSOCIATION	GUNTON TEST STATION	RAY SALMON TEULON
PASQUAI FEEDLOT PROJECT (1984-86)		BOWLES FEEDLOT SWAN RIVER (SIZE: 600)	LYLE MCNICHOL DAUPHIN
ROSSBURN FEEDLOT PROJECT (1983-85)	MARCOS GRASSLAND ASSOCIATION	WAYNE CARSON FEEDLOT ROSSBURN (SIZE: 150)	NORM HAMSTEAD BRANDON
SEVEN SISTERS FEEDLOT PROJECT (1982-89)	EASTERN GRASSLAND SOCIETY	SEVEN SISTERS GRASSLAND	FRASER STEWART BEAUSEJOUR
SPADA FEEDLOT PROJECT (1985-89)	SPADA	CLINT DOWD FARM SUNDOWN	BILL GRABOWSKY ST. PIERRE
WESTLAKE FEEDLOT PROJECT (1982-85) (1986-89)	WESTLAKE PASTURE ASSOCIATION	RICHLIN FEEDERS OCHRE RIVER (SIZE: 1500)	LYLE MCNICHOL DAUPHIN

All projects had different objectives that were developed at the local level. The major ones were:

FEEDLOT PROJECT OBJECTIVES:

PROJECT NAME	OBJECTIVES
DELEAU	- FINISH STEER CALVES AT 12-14 MONTHS OF AGE. - AFFECT OF GENETICS ON PROFIT. - DEMONSTRATE EFFECTIVE FEEDLOT MANAGEMENT.
DOUGLAS	- FINISH STEER CALVES AT 12-14 MONTHS OF AGE. - IMPORTANCE OF GENETICS ON PROFIT.
ETHELBERT	- DEMONSTRATE ON-FARM FINISHING AND FARM MIXED RATIONS. - COMPARISON OF VARIOUS IMPLANTS.
INTERLAKE	- ECONOMICS OF FINISHING VS. SELLING HEIFER CALVES. - AFFECT OF LONG ACTING PENICILLIN. - MINERALS (POTASSIUM PLUS CALCIUM) FOR FOUNDER.
ROSSBURN	- DEMONSTRATE EFFICIENT AND ECONOMIC FEEDING PRACTISES. - ECONOMICS OF GENETICS AND QUALITY ON PROFIT.
SEVEN SISTERS	- ECONOMICS OF FINISHING BULLS VS.STEERS (1983-84) - FEEDING LARGE VS. SMALL FRAME STEERS (1985-86) - ECONOMICS OF MORE FORAGE IN FINISHING PROGRAM.
SPADA	- DEMONSTRATE ON-FARM FINISHING. - EMPHASIS ON LOW COST FACILITIES AND ON-FARM RATIONS. - AFFECT OF GENETICS (A.D.G.) ON PROFIT.
WESTLAKE	- FINISH YEARLING STEERS OFF PASTURE. - COMPARE BARLEY VS. CORN SILAGE. - COMPARE IMPLANTS. - ECONOMICS OF FINISHING SPAYED HEIFERS.

The major reasons for the success of the project was the producer involvement. They had an opportunity to plan and organize local projects. In addition, they had an opportunity to evaluate their own cattle against others, leading some to purchase performance-tested cattle. Because of the emphasis on economics, all producers became better versed on calculating their own cost of production. Other highlights included related extension activities and the opportunity to follow cattle through the system.

All the projects were successful because they were initiated by producer groups in response to local needs. A total of 318 producers have contributed 1,343 animals to date.

In almost all cases, producers contributed cattle, cost of feed and freight, while the project contributed labor, yardage and fall treatment costs. Average cost per project was around $8,000.

FEEDLOT PROJECT SIZE

SITE	NO. OF ANIMALS		NO. PRODUCERS
Deleau	1985-86	100	25
	1986-87	102	24
Douglas	1985-86	100	25
	1986-87	100	25
Ethelbert	1986-87	100	15
Interlake	1985-86	56	18
	1986-87	58	18
Rossburn	1983-84	98	22
	1984-85	104	25
Seven Sisters	1983-84	39	20
	1984-85	68	15
	1985-86	60	15
SPADA	1983-84	58	19
	1984-85	60	20
WestLake	1983-84	112	16
	1984-85	128	16
TOTALS (to date)		1343	318

Cattle were brought to the feedlot site by producers. In most cases, calves were to be dehorned and castrated earlier. Other treatments followed at the site, as follows:

HERD HEALTH PROGRAM

SITE	TREATMENTS
DELEAU	VACCINATED WITH IBR; P13, 8-WAY AND ITEME, INJECTED WITH IVOMEC AND VITAMIN ADE. IMPLANTED WITH GROWTH PROMOTANT.
DOUGLAS	VACCINATED WITH IBR; P13; 8 - WAY, AND ITEME. INJECTED WITH IVOMEC AND VITAMIN ADE, GROWTH PROMOTANT USED.
ETHELBERT	VACCINATED WITH IBR; P13, BVD RESBO 3; 8 - WAY VACCINE, VITAMIN ADE, IMPLANTED WITH COMPUDOSE, SYNOVEX, AND RALGRO, IVOMEC INJECTED TWO WEEKS LATER.
INTERLAKE	VACCINATED FOR BLACKLEG, INTRA-NASAL IBR USED. LONG ACTING PENICILLIN ON HALF THE HERD USED. IVOMEC INJECTED, HEIFEROID IMPLANTED.
ROSSBURN	VACCINATED WITH IBR, P-13, AND 8-WAY VACCINE, SPOTTON APPLIED, IMPLANTED WITH RALGRO..
SEVEN SISTERS	VACCINATED FOR BLACKLEG, MALIGNANT EDIMA, IBR, AND TREATED FOR WARBLES AND LICE, IMPLANTED WITH RALGRO.
SPADA	VACCINATED FOR BLACKLEG, IBR, WARBLES, AND LICE. IMPLANTED WITH COMPUDOSE. EXTRA SALT IN RATION TO GET CATTLE DRINKING MORE WATER. MEDICATION USED THROUGH WATER, IF NECESSARY.
WESTLAKE	VACCINATED WITH VITAMIN A, 2 - WAY BLACKLEG, RESBO 3 (IBR, BVD, AND P-13). SPOTTON APPLIED. IMPLANTS USED WERE COMPUDOSE, STEEROID, AND RALGRO.

Death loss was extremely low and, generally speaking, health of animals was not a major concern.
The Interlake project conducted a trial on long acting penicillin on half the herd but had no appreciable differences.

Cattle were put on various type starter programs to get them on feed. Here is a summary of the various starter rations used:

STARTER RATIONS USED

	DEL.	DOUG.	ETHEL.	INT.	ROSS.	S.S.	SPADA	WEST.
BARLEY OR CORN SILAGE	-	-	-	-	-	-	-	37.6 lb.
OATS	784	784	841	-	484	784	741	-
BARLEY	-	-	-	944	-	114	-	9 lbs.
BEET PULP	334	334	944	-	-	74	84	-
STRAW	-	-	274	-	954	-	134	-
SOYBEAN	-	-	-	-	34	-	-	-
MINERALS	-	-	-	-	14	-	14	-
SALT	14	14	-	14	14	-	-	-
MOLASSES	14	14	-	-	-	-	-	-
SUPPLEMENT	54	54	944	34	-	74	54	-
RUMENSIN	YES	YES	YES	YES	YES	YES	YES	YES
POTASSIUM CHLORIDE				13 lb/ tonne				
MEDICATED FEED	NO	NO	YES	NO	NO	NO	NO	NO
METHOD OF PREPARATION	FEED MILL PREP.	FEED MILL PREP.	ON SITE PREP.	ON SITE PREP.	ON SITE PREP.	ON SITE PREP.	ON SITE PREP.	FEED MILL PREP.

In all cases, rations were professionally balanced. Agri-business was closely involved in all aspects.

In most of the projects, animals were sorted by weight and frame size and fed accordingly. The complete project results are summarized below:

FEEDLOT RESULTS

SITE	YEAR	PEN	STARTING WEIGHT	DAYS ON FEED	FINISHED WEIGHT	A.D.G.	COMMENTS
DELEAU	1985-86	#1	718	165	1158	3.07	-
		#2	590	158	1070	3.05	
DOUGLAS	1985-86	#1	573	173	1121	2.97	
		#2	670	165	1187	3.19	
		#3	552	159	990	2.81	
		#4	621	171	1193	3.01	
ETHELBERT	1986-87	#1	650	-	-	-	
		#2	575	-	-	-	
		#3	525	-	-	-	
INTERLAKE	1985-86	#1	590	188	971	2.03	Heifers (top group)
		#2	590	206	1037	1.56	Heifers (bottom group)
ROSSBURN	1983-84	#1	680	160	1096	2.61	
		#2	556	179	1020	2.55	
	1984-85	#1	717	163	1180	2.90	
		#2	579	176	1081	2.60	
SEVEN SISTERS	1984-85	#1	586	210	1197	2.90	*includes pasture phase
		#2	461	350*	1246	2.19	
	1983-84	#1	495	264	1137	2.43	Steers
		#2	470	250	1209	2.75	Bulls
SPADA	1983-84		566	206	1113	2.80	
	1984-85		599	210	1129	2.81	
WESTLAKE	1984-85	#1	859	102	1112	2.47	Corn silage
		#2	873	97	1109	2.42	Barley silage

HIGHLIGHTS OF RESULTS:

- PROGRAM AT EGS SHOWED HIGH QUALITY FORAGE CAN BE AN ECONOMIC ALTERNATIVE FOR THE RIGHT TYPE OF CATTLE E.G. THOSE WITH FAIR AMOUNT OF BRITISH BREEDING AND FINISH AT ABOUT 1150 LBS.
- BULLS FED OUT AT EGS GAINED BETTER THAN STEERS BUT HAD PROBLEMS RELATED TO MARKETING BECAUSE OF DARK CUTTER AND LACK OF FINISH.
- GRADING NO PROBLEM AT INTERLAKE WITH HEIFERS EXCEPT FOR ONE REFERRED TO AS 'WILD' THAT WENT AS A DARK CUTTER.
- GOOD RESULTS AT PROJECTS WHERE GROWTH PROMOTANTS EVALUATED.
- NO SIGNIFICANT DIFFERENCE BETWEEN CORN SILAGE AND BARLEY SILAGE AT WESTLAKE PROJECT.
- ROSSBURN AND SPADA PROJECTS SHOWED VERY STRONG CORRELATION BETWEEN A.D.G. AND PROFIT.
- VARIABILITY IN DRESSING PERCENTAGE MEANT A DIFFERENCE OF $100 PER STEER.
- PRODUCERS SURPRISED THAT STEERS READY AT 12-14 MONTHS OF AGE.

The major results to emerge from the projects was the high link between good quality cattle and profit. Very clearly, some of the projects, such as Rossburn and SPADA showed the profitability of cattle with a high A.D.G. against those with a low A.D.G.

ROSSBURN RESULTS

A.D.G.	NET PROFIT 1984	1985
1.99	-$56.65	-$110.81
2.0-2.25	3.21	- 59.65
2.26-2.50	6.24	- 14.66
2.51-2.75	45.23	29.99
2.76-3.00	85.82	71.24
3.01-3.50	117.39	111.36
+3.50	-	171.99

PROFIT BASED ON PERFORMANCE:

(SPADA)

	A.D.G.	AVERAGE INIT. WT. (lbs.)	AVERAGE FINAL WT. (lbs.)	AVERAGE PROFIT
TOP 1/3 BASED ON A.D.G.	3.03	591	1228	$212.09
MIDDLE 1/3 BASED ON A.D.G.	2.94	598	1204	$157.57
BOTTOM 1/3 BASED ON A.D.G.	2.46	609	1136	$ 81.89
HIGHEST	3.39	535	1275	$324.09
LOWEST	2.13	610	1075	$ 20.91

The SPADA project evaluated variation in dressing percentage. Cattle were weighed leaving the project site, assessed a 5% shrink and given a dressed weight percentage based on carcass weight. The range in dressed weights was from 55.19% to 61.52%. This difference alone was $100 per steer net. Producers became more aware of the need to select for carcass characteristics:

SPADA CARCASS RESULTS

(1984-85)

	BEST STEER	WORST STEER	AVERAGE
STARTING WEIGHT	725	535	599
FINAL WEIGHT (NET)	1316	1125	1129
CARCASS WEIGHT	788	590	661
A.D.G.	3.49	2.48	2.81
DRESSING %	61.52%	55.19%	58.51%
GRADE	A1H	A1L	

7 A1H
50 A1A2S
3 A1L

The Westlake Project looked at the grading results of their cattle. Results are summarized as follows:

AVERAGE NET RETURN
WESTLAKE PROJECT

	1983-84	1984-85
BARLEY SILAGE	$50.16	$ 8.69
CORN SILAGE	$85.34	$17.50

WESTLAKE MARKET RESULTS

1984-85	1983-84	Grade	Wt.Range	Comments
147 Head	112 Head	TOTAL		
105 Head	99 Head	A1-A2	566-721	Top Price
20 Head	7 Head	A1H-A2H	722-825	3¢ Discount for Heavy Carcass
1 Head		A1XH	826-935	6.72¢ Discount for Extra Heavy
19 Head	4 Head	A1L-A2L	501-565	3¢ Discount (2.3-3.5¢ in 84-85) for light carcass
	1 Head	A3L	501-565	10¢ Discount over fat
2 Head	1 Head	A3	565-721	6¢ Discount over fat 1983-84 (10-11.23¢ discount 1984-85)

Although the projects are recognized as being very successful as an extension tool, some of the following concerns were expressed by staff and producers involved:

- there was variability in genetics and weights of cattle involved.
- cattle selected by producers may not have been typical of their cattle at home.
- producers tended to pay too much attention to the economic figures, e.g. net profit and did not adjust for their own situation.

- there appeared to be very little co-ordination between the various projects in reporting results.
- in some cases, the reports tended to be vague and hard to read.
- there was no method of evaluating shrink or carcass results because of difficulty in getting live weights at the plants.
- there is no permanent record summarizing all project results.

In summary, however, the projects have been rated as highly successful by producers involved because of the emphasis on local concerns. The information generated has been very successful in promoting good feedlot management at the on-farm level. Producers became more knowledgeable in assessing degree of finish and marketing procedure. They became better able to calculate their own costs of production and they became aware of the need to have good quality cattle in a finishing program.

Manitoba Pasture Demonstration Projects

Pasture is not always recognized by many Manitoba farmers as being a crop - yet with adequate management of both the forage and the livestock to harvest this crop, it is perhaps one of the most economic and energy efficient crops for some Manitoba soils.

Pasture, too often has not being rated as warrenting that extra attention to produce the most economic return to the land base. Yet returns from properly managed pastures have resulted in liveweight gains per acre on many demonstrations sites throughout the Province of 250-350 lbs of liveweight gain per acre. With additional supplemental feed, these returns have been recorded as high as 907 lbs per acre. After adjusting for the input costs, including lower energy and machinery costs, the return to the land base can be very profitable.

Pasture is a very energy efficient crop. One recent study, estimated that the fossil energy required to produce a crop of corn was one unit of energy to produce 2.5 units of digestible feed energy. Corn silage ratio was 1 to 4.1, alfalfa 1 to 7.5, but pasture was calculated as requiring 1 unit of fossil energy to produce 40 to 100 units of D.E. This is due to the fact that the livestock harvest the feed themselves and at the same time return nutrients to the land.

In the process of technology transfer, Manitoba Agriculture has placed considerable emphasis on the use of demonstrations to help producers observe the potential of this crop on their farm operations. The first major organized approach was in 1973 by Peter Jones, at that time Grassland Specialist with Manitoba Agriculture in the Interlake area. Through the use of a major central demonstration project which involved a large number of livestock producers, he demonstrated the economic potential of grassland farming. He brought recognition to the fact that grass was a crop and if properly managed could provide a good return to the land base. Most of these earlier demonstrations, however centered on improved pastures using productive pasture forages and fertility rates not commonly used on pastures in Manitoba. A livestock management system that was complimentary to the grassland management was also required. The concept of profitability at this time was also emphasised of a return to grassland in terms of liveweight gain to the land base eg: lbs of beef or milk per acre.

Many of the pasture demonstrations on tame pastures have recorded some excellent results in past years as has been recently summarized by Gerry Breakey, Grassland Specialist Man. Agric.

Tame Pasture Production - Man. Grassland Projects

Stock	Yearling Steers			Dairy Calves	Yearlings
	Ashern	Binscarth	Marco	S.Sisters	St Claude
No. of head	110	107	70	38	75
Acre/animal	1.1	1.0	1.1	0.75	1.25
Gain/head	274	258	264	193	243
Avg.Daily Gain	2.28	2.13	2.15	1.61	1.91
Gain/acre	251	258	240	257	194

Most of these pasture demonstrations although having an impact at the local level, did not generate wide spread interest. This was due in part to the more accepted cropping alternatives for the cultivated land and also the low livestock prices.

The use of improved pastures was not common 15 years ago in many beef herds and still is not the norm today. A recent survey of beef producers indicated that 72% of the producers used unimproved pasture. This is perhaps due to the fact that most of the larger beef herds are located in the more marginal soils areas of the Province where cultivated land base is minimal.

In recent years, many of the pasture demonstration projects have been adapted to systems using both improved pastures and unimproved in a complimentary system.

One example is of the Ralph Connor pasture in the Interlake area where 96 acres of tame forage is grazed in a complimentary system with 880 acres of unimproved pasture.

Complimentary Grazing System (Ralph Connor Pasture)

Yearling Steers (5 year summary)

Weight on pasture	635 lbs	Acres/yearling steers
off pasture	885 lbs	Improved pasture . 0.52 (96 acres)
Avg. Gain per Head	250 lbs	
Days on Pasture	129	Native pasture 4.78 (880 acres)
Avg.Daily Gain	1.90 lbs	

This system has been found to be economically advantageous to using either 100% improved pasture which can be very costly, to no improved pasture which severly limits the carrying capacity of the land base. However the key to this and other pasture systems has been the increased use of a planned grazing system to match the growth and development of the forage with the available livestock to harvest the forage.

In the complimentary system the planning would be as follows:

Late spring: (May 20-June 21) - graze improved pasture
Early summer: (June 22-July30) - graze native pasture
Late summer: (Aug 1-Sept 1) - back to improved pasture
Fall: (Sept 1-Sept 22) - free access to all pastures

In recent years, this planning process has become more involved so as to be able to stock pastures at a level to adequately harvest the available forage, remove undesireable weeds and forages yet not overgraze to the detriment of the pasture. This involves closer attention to the rate of growth of the plants so as to be able to plan forward grazings and obtain an accurate record of animal grazing days as this years record will be the basis for next years plan.

As more control is required of the grazing animal to reduce damage from overgrazing, more fencing subdivisions are required and this has given rise to the interest in low cost, high power, high tension fencing systems. Smaller paddocks can result in increased stock density and more complete utilization of available forage with less loss through overgrazing.

The effect of increased subdivisions on stock density on a 220 pasture grazing 90 cow/calf units:

No. Pad-docks	Average Paddock Size	Average Grazing Period	Times Grazed Per Year	Total Grazing Days/ Year	ADA/Day In Average Paddock	Stock Density In Avg. Paddock
1	220	150 days	-	150	0.4	0.6
5	44	10	3	30	4.7	1.6
12	18	3.6	3.4	12	13.2	3.8

Pasture subdivision also allows for better use of areas of pasture with wide variations. If it can be established as to the number of animal days per acres (ADA) per paddock, then in divising a grazing plan it is possible to allocate the correct grazing times to paddocks of varying grazing capacity, whether they be improved or unimproved pastures.

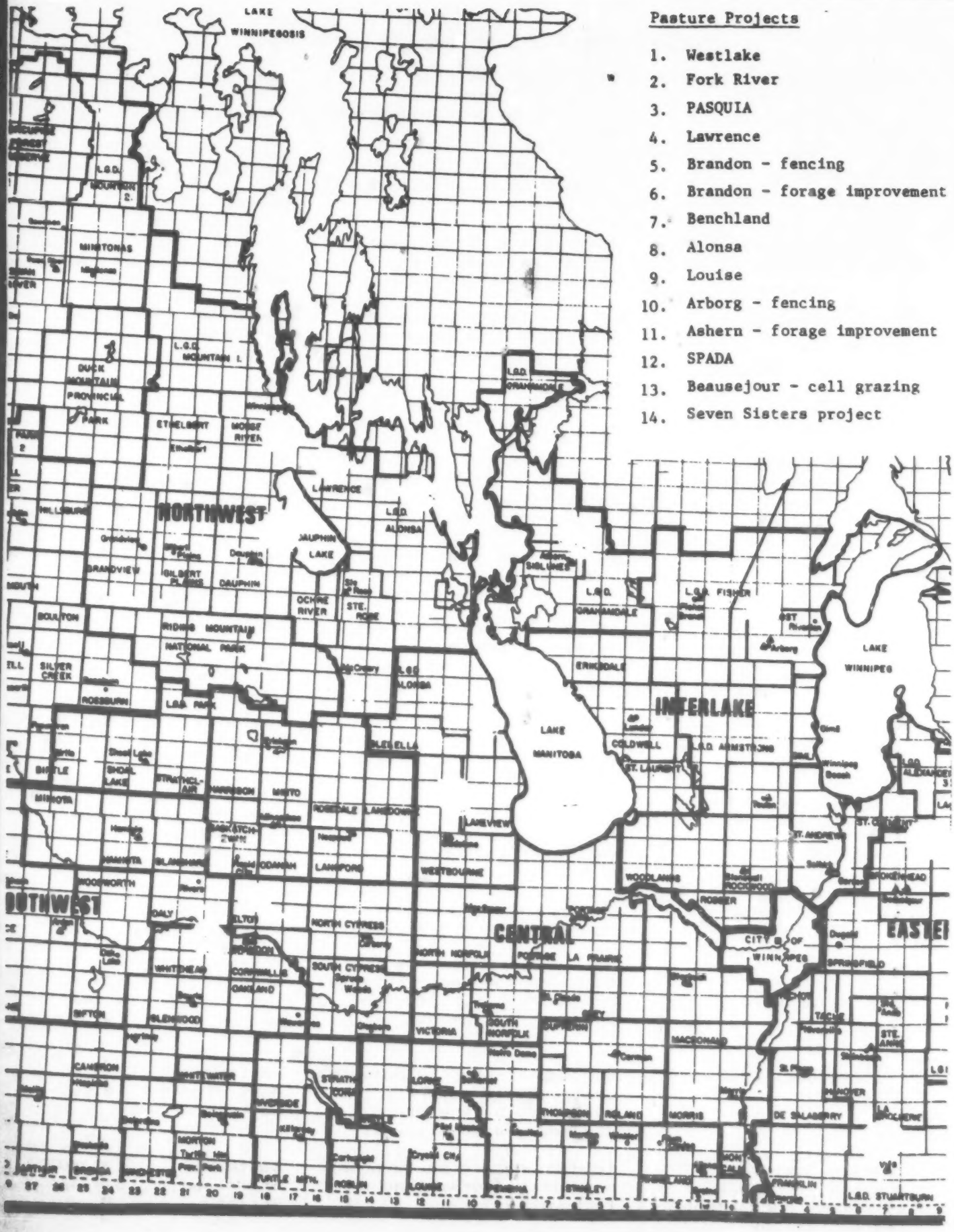
Pasture fencing arrangements are never standard, each must adapt to the individual operation and allow for easy and efficient livestock handling. Some publicity has been given to the cell grazing arrangement which is simply a term that identifies one grazing unit that is handled and managed as a unit. (see Figure I)

Planning is the key to increased forage/livestock productivity and the first step is the identification of goals - what do you want to accomplish with your pasture system ? If you don't know where you want to go you will never know when you get there! If your goal is stated and you fail to achieve it, at least you will know why! Planning is perhaps the major obstacle to improvement in a Grassland system.

Under the Agri-Food program (Table) there are a number of producer associations and extension projects planned for the next 5 years to help with the transfer of forage/ livestock technology. These projects are located in the five regions of the province and the objectives of each project have been developed according to the concerns of the individual producer group. There are also some central demonstration sites that are conducting more in-depth analysis of local forage/livestock problems including regional evaluation of forage systems.

PASTURE DEMONSTRATION PROJECTS - AGRI-FOOD

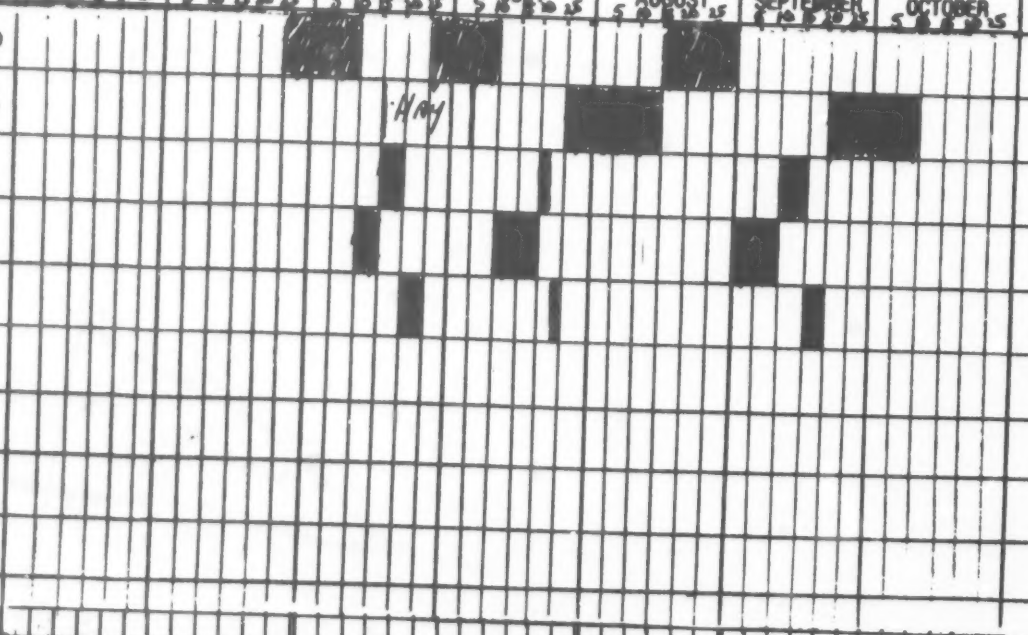
Westlake Heifer Pasture & Finishing Project	to demonstrate profitability of using complimentary pastures to grow and finish heifers.	Westlake Pasture Association	100,000 5 years
Fork River Pasture & Replacement Heifer Project	to demonstrate livestock production from improved grasslands.	Manitoba Agriculture Northwest	
Pasque Grassland & Heifer Project	demonstrate replacement heifer management on improved pasture.	Pasquia Grassland Society	61,000 4 years
Lawrence Cattlemen Forage Co-operation	to demonstrate increased livestock production by forage improvement.	Lawrence Cattlement Co-op	20,000 3 years
High Tensile Fencing Demonstration	to demonstrate the use of high tensile smooth wire for fencing systems.	Manitoba Agriculture Southwest	11,400 4 years
Southwest Forage Improvement Project	to demonstrate forage management practices to increase and stabilize beef production.	Manitoba Agriculture Southwest	45,000 4 years
Benchland Forage Project	to increase pasture and beef productivity through improved forage management.	Benchland Forage Association	181,500 5 years
Alonsa Beef, Forage/ Pasture Improvement Project	to promote economic forage/ livestock production by use of tame forage and grazing management.	Alonsa Forage Association	95,000 4 years
Rotational Grazing & Pasture Management	to demonstrate use of pasture grazing system for efficient forage/livestock production.	Louise Forage Association	45,000 3 years
High Tension Smooth Wire Fencing Demonstration	to demonstrate the use of fencing technology to reduce cost of beef production.	Manitoba Agriculture Interlake	10,000 5 years
Forage Improvement Projects Interlake	to demonstrate recommended forage/pasture management.	Manitoba Agriculture Interlake	70,000 5 years
SPADA Livestock & Forage Technology Transfer	to encourage beef finishing by demonstrating forage/ pasture management technology.	SPADA	125,400 5 years
Pasture Cell Crazing Management	to demonstrate the potential increased livestock productivity by the use of planned grazed systems.	Manitoba Agriculture Eastern	22,000 4 years
Eastern Grassland Society Forage & Livestock Management Demonstrations	to demonstrate the economic benefits of grassland technology.	Eastern Grassland Society	131,400 5 years



Pasture Projects

1. Westlake
2. Fork River
3. PASQUIA
4. Lawrence
5. Brandon - fencing
6. Brandon - forage improvement
7. Benchland
8. Alonsa
9. Louise
10. Arborg - fencing
11. Ashern - forage improvement
12. SPADA
13. Beausejour - cell grazing
14. Seven Sisters project

GRAZING PLAN



ACRE GROWTH YIELD /ACRE	RELATIVE PASTURE QUALITY	No.	SIZE	ESTIMATED A.D.'S AVAILABLE (NON-GROWING)	PASTURE FACTOR	MINIMUM RECOVERY GUIDELINES	PLANNED GRAZED ACRES
	100	1	100			15-25	
	100	4	100			15-25	
	20	7	20			2-5	
	40	8	40			5-10	
	10	9	10			2-3	

	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
21. RAINFALL							
22. SNOW							
23. GROWTH RATE (FGR)							
24. SUPPLEMENT TYPE AND AMOUNT							
25. NUMBER/BREED OF HERDS							
26. PASTURES AVAILABLE		1/70 4	1/70 4	1/70 4	1/70 5	1/70 5	1/70 5
27. SHORTEST/LONGEST RESTS DESIRED		20-40					
28. AMGP		6.6-13.3	6.6-13.3	6.6-13.3	5-10	5-10	5-10
29. ANIMAL UNITS							
30. TYPE OF ANIMALS	No. / AVG WEIGHT / % LIVE	No. / AVG WEIGHT / % LIVE	No. / AVG WEIGHT / % LIVE	No. / AVG WEIGHT / % LIVE	No. / AVG WEIGHT / % LIVE	No. / AVG WEIGHT / % LIVE	No. / AVG WEIGHT / % LIVE
31.							
32.							
33.							
34.							
35.							
36. CELL SIZE:							

A. Estimated Total A.D.'s (Livestock/Wildlife): 477

B. Estimated Days of Non Growth: _____

C. Days of Drought Reserve Required: _____

D. Total Days Grazing Required: 150

E. Estimated Carrying Capacity (S.A.U.'s): _____

AMGP = SHORTEST REST / # PADDOCKS - 1

AMXGP = LONGEST REST / # PADDOCKS - 1

MIN GP = (PADDOCK AD/AVG PAD. AD) x AMGP

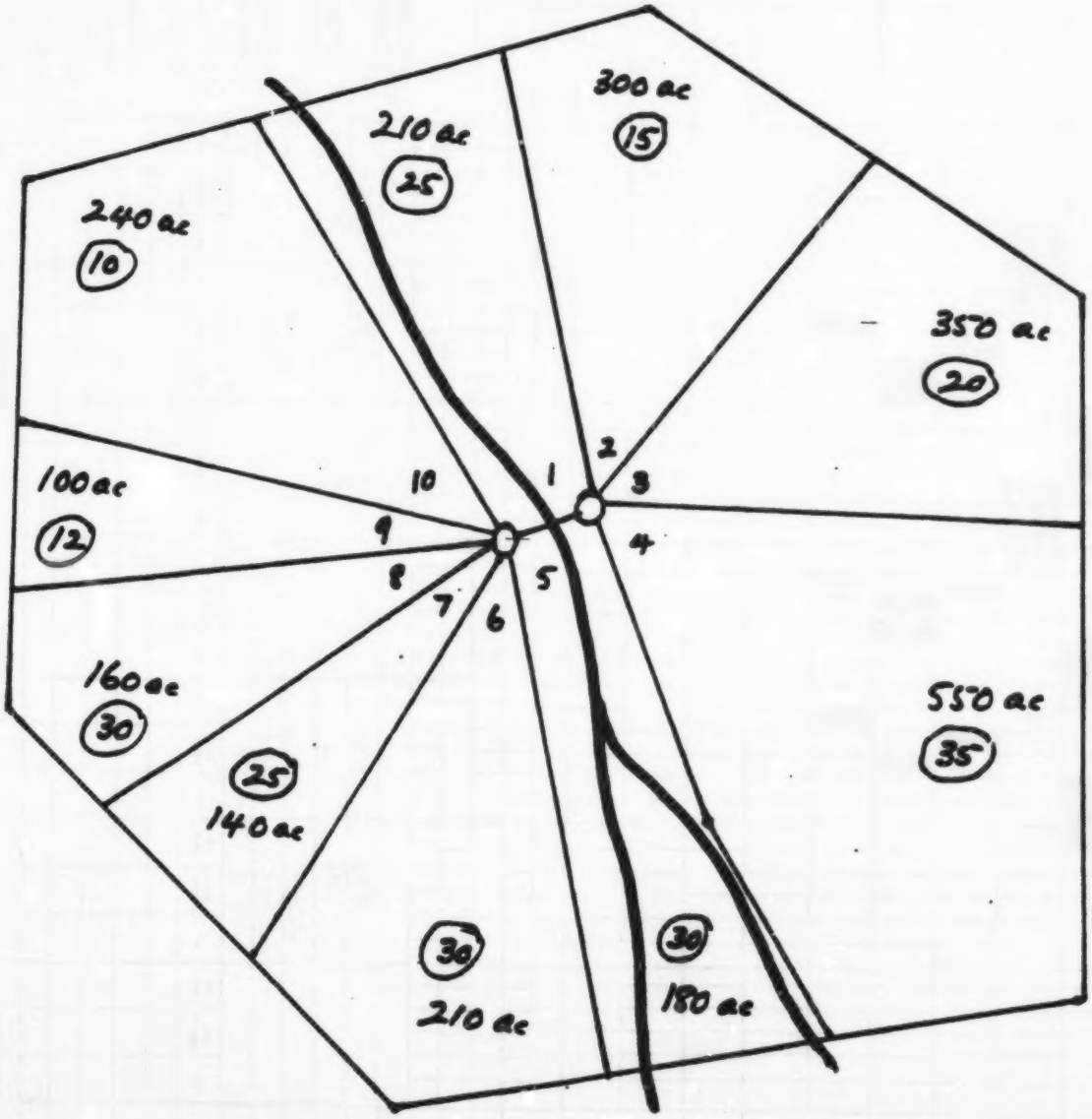
MAX GP = (PAD. AD/AVG PAD. AD) x AMXP

GROWING SEASON: _____ CONCEPTION RATE: _____ WEANING RATE: _____

VEGETATIVE PRODUCTION PER ACRE (HECTARE): _____

AV. ANNUAL PRECIPITATION: _____

PASTURE PLAN



PADDOCK QUALITY FACTOR
IS CIRCLED

Protocol for Evaluation of Hay Preservatives

Dr. K.M. Wittenberg
Department of Animal Science
University of Manitoba

Preservative agents are defined as chemical substances added to food or feed stuffs to prevent decomposition, change and/or to retard spoilage. The concept of using these external chemicals, also referred to as additives, has gained wide acceptance in the past two decades. A hay and silage additive guide compiled by Bolsen and Heidker (1985) listed over 150 products currently in the North American market place. Manitoba Agriculture, in a 1985 survey, identified over 20 different forage preservatives sold to Manitoba producers. Cost comparisons of these products ranged from $1.24 to $28.50/T forage dry matter conserved.

Legislation in many countries requires that ingredients be disclosed for forage preservatives offered for sale. However, there is no obligation on the part of the manufacturer or distributer to enlighten the purchaser of the rationale regarding the inclusion of these ingredients. Alleged benefits are often based on obscure research data or on testimonials. This has created a high degree of uncertainty among forage growers regarding the value of forage preservatives; a situation which unjustly hurts those additives/preservatives that were introduced into the market place on the basis of extensive laboratory and large scale field trials.

Recently changes were made in the Canadian Food and Drug Act in an effort to assess the efficacy of silage and hay preservatives and to provide some regulation on industry claims. In brief the changes require that a nutritional claim will be required by 1987 and that this claim must be supported by statistically analyzable data. A nutritional claim would relate to the conservation or preservation of recognized nutritional elements such as dry matter or crude protein rather than chemical or physical attributes of a non-nutritional nature, such as pH or temperature changes during storage. Accordingly, the Food Protection and Inspection Branch of Agriculture Canada recommend the Nation Feed Ingredients Association Guidelines (AAFCO, 1981) as a guide for evaluation of preservatives and/or additives added to the forages at the time of ensiling. These guidelines do provide protocol for substantiating claims in the areas of:

i) conservation and retention of nutrients during the ensiling process;

ii) improved nutritive value of the ensiled forage crop;

iii) improved animal performance upon feeding the ensiled crop.

Similar guidelines or protocol for efficacy studies of hay preservatives or additives are not available. Several factors should be considered when establishing these guidelines. First, unlike silage, hay is a marketable commodity and therefore factors influencing hay prices should be considered. Along with the nutritional claims discussed for ensiled forages, factors such as presence of mold, dust and color of the hay are considered in hay pricing. Secondly, the microbial and chemical changes taking place in forage stored as hay are not as well documented as for forage that has been ensiled. Unlike

ensiled forages for which nutrients preservation is related to the establishment of anaerobic and acidic conditions, good preservation of hay is related to the inhibition of mold growth. Mold inhibition occurs when one or more of the following conditions are met:

i) forage moisture content is reduced;

ii) unavailable nutrients are used up;

iii) forage material becomes too acidic;

iv) specific antimicrobial compounds are present in the forage.

These differences require special considerations when establishing the protocol for preservative evaluation of hays. *

Literature Cited

Bolsen, K. and Heidken, J.J. 1985. Silage additives U.S.A. Chalcombe Publications, Manhattan, Kansas

Official Publication of the Association of American Feed Control Officials. 1981. Repost of the Silage Ingredients Committee p. 208-210

* A major emphasis in our ERDA research program is related to the development of this protocol. In the process forage preservatives from the following categories are being tested: organic acids, ammonia compound, innoculants, enzymes and nutrients.